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(NASA-CR-161658) COAL GASIFICATION SYSTEMS
ENGINEERING AND ANALYSIS. APPENDIX D: COST
AND ECONOMIC STUDIES Final Report (BDM
Corp., Huntsville, Ala.) 636 p
HC A99/MF A01

N81-18217

Unclas
41565

CSCL 21D G3/28





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COAL GASIFICATION SYSTEMS
ENGINEERING AND ANALYSIS
FINAL REPORT
APPENDIX D - COST AND ECONOMIC STUDIES
December 31, 1980

BDM/H-80-800-TR

This Technical Report is submitted to George C. Marshall Space Flight Center under Contract Number NAS8-33824.

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A. INTRODUCTION AND OVERVIEW

This appendix contains the detailed cost estimate documentation for the designs prepared in this study. The organization of this appendix is as follows:

B. MBG COST ESTIMATES

- (1) Koppers-Totzek
- (2) Texaco
- (3) Babcock and Wilcox
- (4) BGC-Lurgi
- (5) Lurgi

C. ALTERNATE PRODUCT COST ESTIMATES

- (1) Koppers-Totzek and Texaco Single Product Facilities (Methane, Methanol, Gasoline, Hydrogen)
- (2) Koppers-Totzek SNG and MBG
- (3) Koppers-Totzek and Texaco SNG and MBG
- (4) Lurgi-Methane and Lurgi-Methane and Methanol

The cost methodology is described in Appendix E. The cost results are summarized in the accompanying tables. Due to some uncertainty regarding the cost of the B&W gasifier, two cases are considered in the cost analysis of the B&W-based plant. In the first case, base equipment cost for System 2, Gasification, is multiplied by an installation factor of 2.31 to arrive at the installed cost. This factor was arrived at by back calculation from a more detailed cost analysis based on Koppers-Totzek technology. In the second case, an installed equipment cost factor of 1.5 was used based on information from B&W and supplied to this study by NASA. In this report, the first case result is used followed by the second case result in parenthesis. It is noted that discussions presented in Chapter XI imply that higher capacity units such as B&W should have a lower installation factor than low capacity units.

SUMMARY OF MBG FACILITY COSTS
(Millions of Dollars, unless otherwise noted)

Process	Texaco	Koppers-Totzek	Babcock & Wilcox	BGC-Lurgi	Lurgi
Cost Category					
Total Facility Investment (Instant Plant)	1,416	1,591	2,437	1,387	1,879
Total Capital Requirements	2,091	2,371	3,347	2,061	2,747
O&M, Feedstock, Catalyst and Chemicals*	310	370	319	310	366
Feedstock, catalyst and Chemicals	181	181	181	276	279
ORM	129	189	138	100	134
Byproduct credits	0	0	0	(66)	(47)
Annual Product (10 ¹² BTU)	103	90	100	121	117
UAE Cost of Service Price (Current \$/MM BTU)	\$13.38	\$17.79	\$17.11 (14.37)**	\$11.54	\$14.56
Product Price (Constant 1980 \$/MM BTU)	5.00	6.64	6.39 (5.37)**	4.31	5.44

*Total facility and 90% service factor.

** Based on installation factors of 2.31 and 1.5, respectively.

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	<u>METHANE</u>		<u>METHANOL</u>		<u>GASOLINE</u>		<u>HYDROGEN</u>	
	KT	TEXACO	KT	TEXACO	KT	TEXACO	KT	TEXACO
PRODUCT YIELD (10 ¹² BTU/YEAR)	76	84	79	89	61	79	75	95
PRICE								
\$1980/MMBTU	\$8.03	\$7.63	\$8.08	\$7.54	\$11.21	\$9.04	\$8.94	\$7.61
\$1980/GALLON	-	-	\$0.53	\$0.48	\$ 1.25	\$1.01	-	-
\$1980/MMSCF	\$8.03	\$7.63	-	-	-	-	\$2.90	\$2.47

LURGI/METHANE

PRODUCT YIELD (10 ¹² BTU/YEAR)	
TOTAL	94.37
METHANOL ANNUAL PRODUCT	94.37
SNG ANNUAL PRODUCT	-0-
INTEGRATED PRICE (\$1980/MMBTU)	\$7.69

LURGI/METHANE & METHANOL

109.30
58.42
50.28
\$6.81

KOPPERS-TOTZEK/SNG & MBG INTEGRATED FACILITY

PRODUCT YIELD (10 ¹² BTU)	
TOTAL	80.08
SNG ANNUAL PRODUCT	35.04
MBG ANNUAL PRODUCT	45.04
INTEGRATED FACILITY PRODUCT PRICE (\$/MMBTU) (IN CONSTANT DOLLARS)	\$8.02

K-T/TEXACO/SNG & MBG INTEGRATED FACILITY

89.07
37.62
51.45
\$6.49

Summary of Alternate Product Costs

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- B. MBG COST ESTIMATES**
 - 1. Koppers-Totzek MBG**

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a. **Koppers-Totzek System Costs**

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SYSTEM COST DATA

<u>PROCESS:</u>	KOPPEPS-TOTZEK
<u>SYSTEM:</u>	1-COAL PREPARATION & FEED
<u>UNIT OPERATION NUMBER:</u>	11
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	SEE SYSTEM 2 (SYSTEM 2 INCLUDES SYSTEMS 1 & 3)
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	N/A

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SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 2-GASIFICATION
UNIT OPERATION NUMBER: 20
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: EPRI REPORT AF-531 p. 98
REFERENCE SYSTEM COST: \$51,063,000 (1974 DOLLARS)
REFERENCE CAPACITY: 11 GASIFIERS + 1 SPARE
TVA CAPACITY: 8 GASIFIERS + 1 SPARE
RECOMMENDED CAPACITY EXPONENT: 1

EXPLANATORY COMMENTS:

1. FACTOR LINEARLY ON GASIFIER QUANTITY
2. REFERENCE SYSTEM COST INCLUDES SYSTEMS 1 & 3
3. TOTAL 9 PARALLEL TRAINS REQUIRED FOR TVA.
4. BLOWER COST MUST BE DELETED FROM KIT REFERENCE COST PRIOR TO CAPACITY FACTORING. TOTAL BLOWER SYSTEM COST = \$985,600 (1974 DOLLARS)

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR) \times
ESCALATION FACTOR \times CAPACITY FACTOR

TOTAL DIRECT COST = REFERENCE SYSTEM COST - BLOWER SYSTEM COST

BLOWER SYSTEM COST = EQUIPMENT COST ('74 DOLLARS) \times MODULAR FACTOR

INPUTS:

REFERENCE SYSTEM COST: $\$51.063 \times 10^6$ (JANUARY '74 DOLLARS)
INDIRECT COST FACTOR: 0.36 (ASSUME "NORM" .36 L/M RATIO FOR MIXED PROCESS)
ESCALATION FACTOR: 1.51 (TO JANUARY '80 DOLLARS)
CAPACITY FACTOR: .75
EQUIPMENT COST: \$985,600 (1974 DOLLARS)
MODULAR FACTOR: 2.2

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SYSTEM COST DATA (CONTINUED)

RESULTS:

BLOWER SYSTEM COST	=	$\$2.168 \times 10^6$	(JANUARY '74 DOLLARS)
TOTAL DIRECT COST	=	$\$48.90 \times 10^6$	(JANUARY '74 DOLLARS)
TOTAL SYSTEM COST	=	\$75,307,586	(JANUARY '80 DOLLARS)

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SYSTEM COST DATA

<u>PROCESS:</u>	KOPPERS-TOTZEK
<u>SYSTEM:</u>	3-INITIAL GAS CLEAN-UP & COOLING
<u>UNIT OPERATION NUMBER:</u>	21
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	SEE SYSTEM 2
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	N/A

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK PROCESS, SYSTEM NO. 1, 2, 3
COAL PREPARATION, FEED, GASIFICATION, INITIAL GAS CLEAN-UP & COOLING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL: _____	\$75.308	\$75.308	\$75.308	\$75.308
TOTAL PROCESS CONTINGENCY - 15%				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL: _____	\$ 11.296	\$ 11.296	\$ 11.296	\$ 11.296
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 86.604	\$ 86.604	\$ 86.604	\$ 86.604

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SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 4-ACID GAS REMOVAL - SELEXOL
UNIT OPERATION NUMBER: 22
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: EPRI AF-916, CASE 48
REFERENCE SYSTEM COST: \$54,227,000 (MID-'76 DOLLARS)
REFERENCE CAPACITY: 407,775 ACFH
TVA CAPACITY: 289,436 ACFH
RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

THE REFERENCE SYSTEM CONTAINS 3 PARALLEL TRAINS. REFERENCE CAPACITY
EQUALS 1/3 OF REFERENCE SYSTEM. TVA REQUIRES ONE TRAIN.

COMPUTATION METHOD:

TOTAL SYSTEM COST = $\frac{1}{3} \times \text{REFERENCE SYSTEM COST} \times \text{CAPACITY FACTOR}$
x ESCALATION FACTOR

CAPACITY FACTOR = $\left(\frac{\text{TVA ACFH}}{\text{EPRI ACFH}} \right)^{0.6}$

INPUTS:

REFERENCE SYSTEM COST: $\$54.227 \times 10^6$ (MID-'76 DOLLARS)

CAPACITY FACTOR: $\left(\frac{289,435}{407,775} \right)^{0.6} = .814$

ESCALATION FACTOR: 1.30 (TO JANUARY '80 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$19,130,081 (JANUARY '80 DOLLARS)

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK PROCESS, SYSTEM NO. 4, ACID GAS REMOVAL, SELEXOL SUBSYSTEM INVESTMENT/AGGREGATION TABLE

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4	FACILITY TOTAL
TOTAL DIRECT PLUS INDIRECT COSTS					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SYSTEM SUBTOTAL:	\$ 19.131	\$ 19.131	\$ 19.131	\$ 19.131	\$ 76.524
TOTAL PROCESS CONTINGENCY: 5%					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SYSTEM SUBTOTAL:	\$ 0.957	\$ 0.957	\$ 0.957	\$ 0.957	\$ 3.828
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 20.088	\$ 20.088	\$ 20.088	\$ 20.088	\$ 80.352

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SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK

SYSTEM: 5-SULFUR RECOVERY & TAIL GAS TREATMENT

UNIT OPERATION NUMBER: 36

SUBSYSTEM: INSTALLATION COST FACTORS

REFERENCE SOURCE FOR COSTING: DOE REPORT FE-1775-18, PLANT 2, p. 9-13

REFERENCE SYSTEM COST*: \$9,032,000 MID-1977 DOLLARS (TOTAL DIRECT COSTS)

REFERENCE CAPACITY: 181.2 LT/D SULFUR PRODUCT

TVA CAPACITY: 165.2 LT/D SULFUR PRODUCT

RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

1. PROCESS NOTE: NORMAL OPERATING RATE OF PLANT 2 IS 240 M/H FEED ALTHOUGH DESIGN IS FOR 527.5 M/H.
2. PROVIDE 2 TRAINS FOR MODULE 1 (1 SPARE) PLUS 1 TRAIN FOR EACH ADDITIONAL MODULE.

COMPUTATION METHOD:

$$\begin{aligned}\text{CAPACITY FACTOR} &= \left(\frac{\text{TVA CAP}}{\text{REF CAP}} \right)^{0.6} \\ \text{SINGLE TRAIN COST} &= \text{TOTAL DIRECT COST} \times (1 + \text{INDIRECT COST FACTOR}) \\ &\quad \times \text{CAPACITY FACTOR} \times \text{ESCALATION FACTOR} \\ \text{TOTAL SYSTEM COST} &= \text{SINGLE TRAIN COST} \times \text{NO. OF TRAINS}\end{aligned}$$

INPUTS:

$$\begin{aligned}\text{TOTAL DIRECT COSTS} &= \$9.032 \times 10^6 \text{ (MID-1977 DOLLARS)} \\ \text{INDIRECT COST FACTOR} &= 0.10 \text{ (ASSUMED FROM DOE REPORT)} \\ \text{CAPACITY FACTOR} &= \left(\frac{165.2}{181.2} \right)^{0.6} = .946\end{aligned}$$

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SYSTEM COST DATA (CONTINUED)

ESCALATION FACTOR = 1.22 (FROM 1977 to 1980 DOLLARS)

RESULTS:

SINGLE TRAIN COST = 11,466,413

TOTAL SYSTEM COST:

MODULE 1 = \$22,932,826 (JANUARY '80 DOLLARS)

MODULES 2-4 = \$11,466,413 (JANUARY '80 DOLLARS)

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK PROCESS, SYSTEM NO. 5, SULFUR RECOVERY & TAIL GAS TREATMENT SUBSYSTEM INVESTMENT/AGGREGATION TABLE

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4	FACILITY TOTAL
TOTAL DIRECT PLUS INDIRECT COSTS					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SYSTEM SUBTOTAL:	\$ 22.933	\$ 11.466	\$ 11.466	\$ 11.466	\$ 57.331
TOTAL PROCESS CONTINGENCY: 15%					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SYSTEM SUBTOTAL:	\$ 3.440	\$ 1.720	\$ 1.720	\$ 1.720	\$ 8.6
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 26.373	\$ 13.186	\$ 13.186	\$ 13.186	\$ 65.931

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SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK

SYSTEM: 6-AIR SEPARATION

UNIT OPERATION NUMBER: 80

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: COST ESTIMATING - RELATIONSHIP CURVES
(REFER TO AIR SEPARATION ATTACHMENT)

REFERENCE SYSTEM COST: $\$36.8 \times 10^6$ (JANUARY '80 DOLLARS PER TRAIN)

REFERENCE CAPACITY: 4,104 TPD AIR SEPARATION PLANT OR 2,052
TPD FOR TWO AIR SEPARATION PLANTS @ 24.7
psia OXYGEN.

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THE SYSTEM CONSISTS OF TWO TRAINS FOR EACH MODULE.
2. THE INSTALLATION COST OF THE 1st TRAIN DIFFERS FROM THE OTHERS (MODULE 1).

COMPUTATION METHOD:

TOTAL SYSTEM COST:
MODULE 1 = INSTALLED COST FOR TWO TRAINS

MODULES 2-4 = SINGLE TRAIN COST x 2 TRAINS (FOR EACH MODULE)

INPUTS:

TRAIN COSTS (MODULE 1): 1st - $\$37.9 \times 10^6$ (JANUARY '80 DOLLARS)
2nd - 36.8×10^6 (JANUARY '80 DOLLARS)

TRAIN COSTS (MODULE 2-4): $\$36.8 \times 10^6$ (JANUARY '80 DOLLARS)

RESULTS:

TOTAL SYSTEM COST: MODULE 1 = $\$74.7 \times 10^6$ (JANUARY '80 DOLLARS)

MODULES 2-4 = 73.6×10^6 (JANUARY '80 DOLLARS) -
FOR EACH MODULE

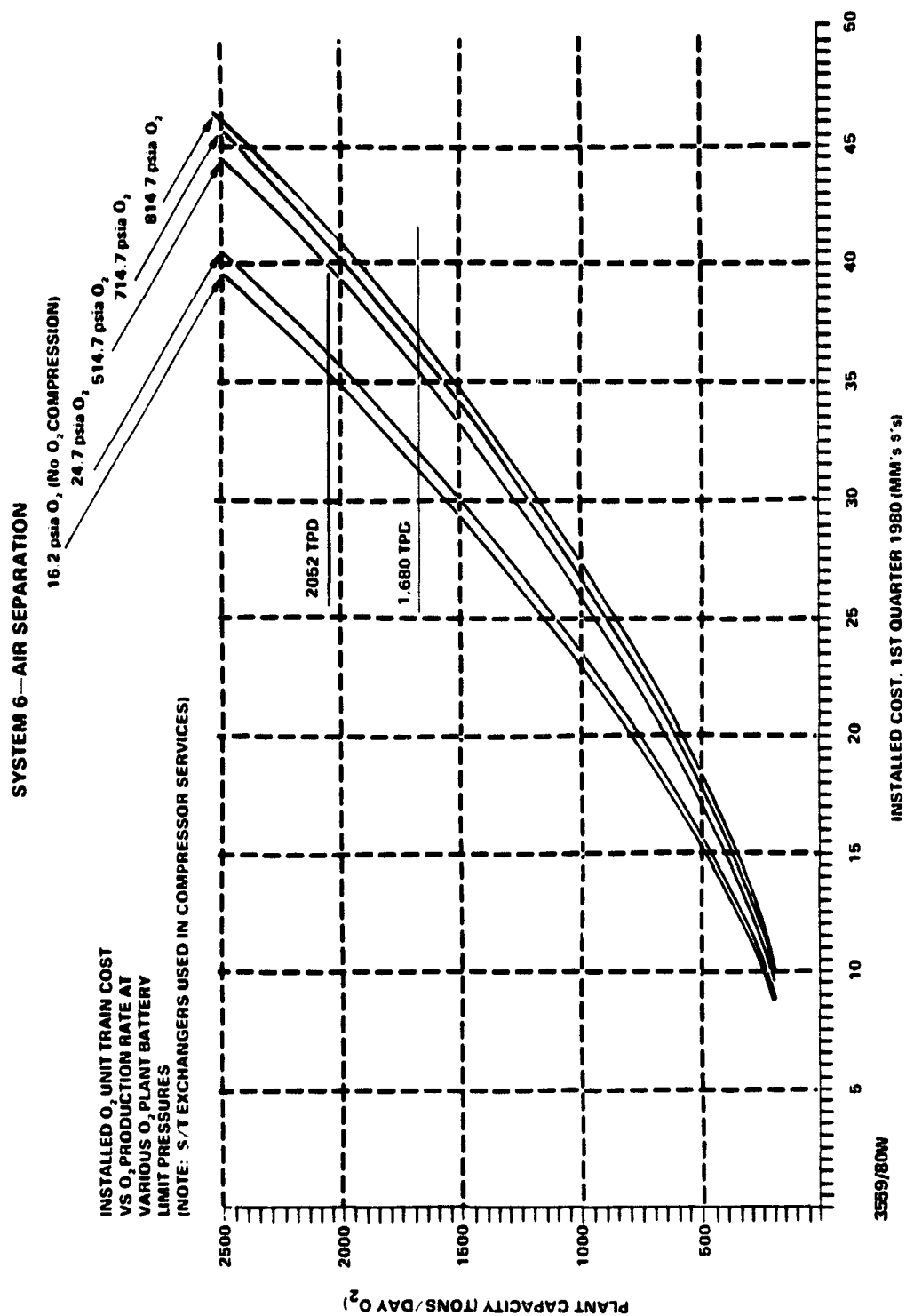


Figure III-1. Air Separation Plant Installed Cost

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK PROCESS, SYSTEM NO. 6, AIR SEPARATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$74.70	\$73.60	\$73.60	\$73.60
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$74.70	\$73.60	\$73.60	\$73.60

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SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 7-GAS COMPRESSION
UNIT OPERATION NUMBER: 23
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: VENDOR ESTIMATE
REFERENCE SYSTEM COST: \$10,529,000 (JANUARY 1980 DOLLARS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 14,720,000
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. 1 TRAIN PER MODULE.
2. PRICE INCLUDES MOTOR DRIVERS.
3. COST IS EQUIPMENT ONLY.
4. USE 2.15 INSTALLED COST FACTOR PER GUTHRIE, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL. p. 167.

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST x MODULAR FACTOR

INPUTS:

REFERENCE SYSTEM COST: $\$10.529 \times 10^6$ (JANUARY '80 DOLLARS)
MODULAR FACTOR: 2.15

RESULTS:

TOTAL SYSTEM COST = $\$22.638 \times 10^6$ (JANUARY '80 DOLLARS)

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK PROCESS, SYSTEM NO. 7, GAS COMPRESSION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$22.638	\$22.638	\$22.638	\$22.638
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 22.638	\$ 22.638	\$ 22.638	\$ 22.638

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SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 8-PROCESS SOLIDS TREATMENT (DEWATERING)
UNIT OPERATION NUMBER: 31
SUBSYSTEM: WATER TREATMENT-SLUDGE HANDLING
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: \$75,000 JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)
(SEE TOTAL DIRECT COSTS BELOW)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 16,000 GAL/DAY OF 15% BY WEIGHT OF LIME
SLUDGE
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SUBSYSTEM COST: = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS:

1.	2 LINED PONDS FOR GRAVITY DEWATERING	\$60,000
2.	25% CONTINGENCY FOR ANY CONVEYORS, PUMPS, CHEMICAL FEED, EQUIPMENT, ETC.	15,000
	TOTAL	\$75,000

INDIRECT COST FACTOR: 0.335 (ASSUME .25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SUBSYSTEM COST = \$100,125 (JANUARY '80 DOLLARS)

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SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK

SYSTEM: 8-PROCESS SOLIDS TREATMENT (DEWATERING)

UNIT OPERATION NUMBER: 31

SUBSYSTEM: GASIFIER SLAG DEWATERER

REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE

REFERENCE SYSTEM COST: \$569,000 JANUARY '80 DOLLARS (TOTAL DIRECT COST) (SEE TOTAL DIRECT COSTS BELOW)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 60,000 #/HR SLAG & ASH
21,420 #/HR H₂O

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COST × (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS

1.	GRAVITY CLARIFIER	\$ 40,000
2.	CONVEYOR TO DISPOSAL PILE	513,000
3.	CHEMICAL FEED	16,000
	TOTAL	\$569,000 (JANUARY '80 DOLLARS)

INDIRECT COST FACTOR: 0.335 ASSUME 0.25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SUBSYSTEM COST = \$759,615 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK PROCESS, SYSTEM NO. 8, PROCESS SOLIDS TREATMENT (DEWATERING)

SYSTEM CAPITAL INVESTMENT TABLE

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4	FACILITY TOTAL
TOTAL DIRECT PLUS INDIRECT COSTS					
SUBSYSTEM NO. WATER TREATMENT					
SLUDGE HANDLING	\$.100	\$.100	\$.100	\$.100	\$.400
SUBSYSTEM NO. GASIFIER SLAG					
DEWATERER	\$.760	\$.760	\$.760	\$.760	\$3.04
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SYSTEM SUBTOTAL:	\$.860	\$.860	\$.860	\$.860	\$ 3.440

TOTAL PROCESS CONTINGENCY:

SUBSYSTEM NO. _____	-0-	-0-	-0-	-0-
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SYSTEM SUBTOTAL:	-0-	-0-	-0-	-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

	\$.860	\$.860	\$.860	\$.860	\$ 3.440
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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 10-INSTRUMENTATION & CONTROL
UNIT OPERATION NUMBER: N/A
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: VENDOR ESTIMATE FROM GENERAL ELECTRIC
REFERENCE SYSTEM COST: $\$1.5 \times 10^6$ (JANUARY 80 DOLLARS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THIS SYSTEM CONTAINS JUST THE NECESSARY MATERIAL FOR THE CENTRALIZED REMOTE FACILITY. IT CONTAINS SUFFICIENT CABLE TO TRANSMIT SIGNALS FROM THE PROCESS UNITS; DATA PROCESSING EQUIPMENT, SOFTWARE PACKAGES FOR THE ANALYSIS OF INCOMING DATA, AND DISPLAY PANELS FOR PRESENTATION OF DATA. THIS SYSTEM DOES NOT INCLUDE LOCAL CONTROLS FOR DIRECT OPERATION OF INDIVIDUAL SYSTEMS.
2. IT IS BASED UPON A HONEYWELL 4500 SYSTEM.

COMPUTATION METHOD:

TOTAL DIRECT COST = (1 + INSTALLATION FACTOR) x REFERENCE COST
TOTAL SYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

FIELD INSTALLATION FACTOR = 1.10 (ASSUMED)
REFERENCE COST = $\$1.5 \times 10^6$ (JANUARY '80 DOLLARS)
INDIRECT COST FACTOR = 0.289 (90/10 ASSUMED M/L RATIO)

RESULTS:

TOTAL DIRECT COSTS = $\$3.15 \times 10^6$ (JANUARY '80 DOLLARS)
TOTAL SYSTEM COST = $\$4.06 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK PROCESS, SYSTEM NO. 10, INSTRUMENTATION & CONTROL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 4.06	\$ 4.06	\$ 4.06	\$ 4.06
TOTAL PROCESS CONTINGENCY: 15%				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 0.609	\$ 0.609	\$ 0.609	\$ 0.609
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 4.669	\$ 4.669	\$ 4.669	\$ 4.669

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK

SYSTEM: 11-SOLIDS WASTE RECYCLING/DISPOSAL

UNIT OPERATION NUMBER: 81

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATE (FROM IN-HOUSE COST DATA BASE)

REFERENCE SYSTEM COST: $\$16.1 \times 10^6$ JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)

DIRECT COST OF SOLIDS DISPOSAL AREA	=	$\$10.0 \times 10^6$
DIRECT COST OF RUNOFF COLLECTION BASIN	=	$\$6.1 \times 10^6$
(BOTH ARE LINED W/CLAY LINER)		$\$16.1 \times 10^6$

REFERENCE CAPACITY: N/A

TVA CAPACITY: 61,000 #/HR SOLIDS (DRY), 2,319 GAL/HR
H₂O WITH SOLIDS

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. SYSTEM IS ESSENTIALLY AN EXCAVATED 20-YEAR AREA FOR SOLID DISPOSAL. INCLUDES EXCAVATION & CONSTRUCT OF CLAY LINED DISPOSAL AREA RUNOFF HOLDING POND.
2. LAND COSTS WERE NOT INCLUDED.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COST: $\$16.1 \times 10^6$ (JANUARY '80 DOLLARS)
INDIRECT COST FACTOR: 0.335 (80/20 ASSUMED M/L RATIO FOR SOLIDS HANDLING SYSTEMS)

RESULTS:

TOTAL SYSTEM COST = $\$21.494 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK PROCESS, SYSTEM NO. 11, SOLIDS WASTE RECYCLING/DISPOSAL

SYSTEM CAPITAL INVESTMENT TABLE

ITEM DESCRIPTION	KOPPERS				FACILITY TOTAL
	81 FINAL SOLIDS DISPOSAL	MODULE 1	MODULE 2	MODULE 3	MODULE 4
TOTAL DIRECT PLUS INDIRECT COSTS					
SUBSYSTEM NO. LINED DISPOSAL AREA		\$ 13.350	\$ 13.350	\$ 13.350	\$ 13.350
SUBSYSTEM NO. RUNOFF COLLECTION		\$ 8.144	\$ 8.144	\$ 8.144	\$ 8.144
<u>SYSTEM SUBTOTAL:</u>		\$ 21.494	\$ 21.494	\$ 21.494	\$ 21.494
					\$ 85.976

TOTAL PROCESS CONTINGENCY:

SUBSYSTEM NO.	—
SUBSYSTEM NO.	—
SUBSYSTEM NO.	—
SUBSYSTEM NO.	—
SUBSYSTEM NO.	—
SUBSYSTEM NO.	—
<u>SYSTEM SUBTOTAL:</u>	—

<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 21.494	\$ 21.494	\$ 21.494	\$ 21.494	\$ 85.976
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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK

SYSTEM: 12-COAL HANDLING

UNIT OPERATION NUMBER: 10

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: EQUIPMENT FACTORED COST ESTIMATE BY
RESOURCE ENGINEERING, INC. BASED ON
VENDOR QUOTES AND HISTORIC DATA. SEE
DETAILED EQUIPMENT LISTING WHICH FOLLOWS.

REFERENCE SYSTEM COST: \$48,100,000 JANUARY '80 DOLLARS (TOTAL
DIRECT COSTS)

REFERENCE CAPACITY: 920,000 TONS OF COAL PER DAY

TVA CAPACITY: 20,000 TONS OF COAL PER DAY

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS SYSTEMS IS SIZED TO SERVE THE NEEDS OF ALL FOUR MODULES TO BE
BUILT IN THE FACILITY.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COST = \$48,100,000 (JANUARY '80 DOLLARS)
INDIRECT COST FACTOR = 0.335 (80/20 ASSUMED M/L RATIO FOR SOLIDS HANDLING
SYSTEMS)

RESULTS:

TOTAL SYSTEM COST = $\$64.214 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM 12

COAL HANDLING

(EQUIPMENT FACTORED COSTS)

<u>DESCRIPTION</u>	<u>JANUARY 1980 IN MILLION DOLLARS (10⁶)</u>
1. Continuous barge unloader, elevator type, 3,000-3,500 TPH, including dock, moorings, surge bin, conveyors	\$ 10.0
2. Open coal storage piles, 1.8 x 10 ⁶ tons Double windows 100' high x (2 x 240') wide x 2,800' Costs for site preparation, stockpiling conveyors, stacker/reclaiming equipment, mobile equipment	30.0
3. Rotary brakers, three (2N, 1S), 1,000 TPH each 50 hp each, 12' ϕ x 22' each	1.0
4. Concrete silos, four, 11,750 tons each, 67' ϕ x 150' each	6.0
5. Truck dump hopper, 2,000 tons	0.2
6. Conveyors not included above	
a. Truck station to crusher, 500 TPH 36" x 500 ft., 0 elevation, 426 fpm, 32 hp	0.3
b. Crusher to silos, 2,160 TPH 60" x 700 ft., 150 ft. elevation, 470 hp, 600 fpm	<u>0.6</u>
TOTAL DIRECT COSTS (E+M+L) =	\$ 48.1

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
KOPPERS-TOTZEK PROCESS, SYSTEM NO. 12, COAL HANDLING
SYSTEM CAPITAL INVESTMENT TABLE

GENERAL FACILITIES

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS
SUBTOTAL:

\$ 64.214

TOTAL PROCESS CONTINGENCY:
SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 64.214

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	KOPPERS-TOTZEK
<u>SYSTEM:</u>	13-BYPRODUCTS PROCESSING
<u>UNIT OPERATION NUMBER:</u>	83
<u>SUBSYSTEM:</u>	SULFUR STORAGE AND LOADING
<u>REFERENCE SOURCE FOR COSTING:</u>	MITTELHAUSER IN-HOUSE COST DATA BASE
<u>REFERENCE SYSTEM COST:</u>	$\$1 \times 10^6$ (JANUARY '80 DOLLARS)
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	

TOTAL SYSTEM COST = $\$1 \times 10^6$ (JANUARY '80 DOLLARS)-PER MODULE

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK PROCESS, SYSTEM NO. 13, BYPRODUCTS PROCESSING SUBSYSTEM INVESTMENT/AGGREGATION TABLE

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4	FACILITY TOTAL
TOTAL DIRECT PLUS INDIRECT COSTS					
UNIT OPERATIONS 83-SULFUR					
STORAGE AND LOADING	\$ 1.0	\$ 1.0	\$ 1.0	\$ 1.0	
SYSTEM SUBTOTAL:					
TOTAL PROCESS CONTINGENCY:					
SUBSYSTEM NO. _____	-0-	-0-	-0-	-0-	-0-
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SYSTEM SUBTOTAL:					
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 1.0	\$ 1.0	\$ 1.0	\$ 1.0	\$ 4.0

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK

SYSTEM: 14-PLANT POWER SYSTEM

UNIT OPERATION NUMBER: 87

SUBSYSTEM: DISTRIBUTION COSTS

REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA, FROM
PROCESS PLANT ESTIMATING, AND CONTROL.
p. 363.

REFERENCE SYSTEM COST: \$102.60 (1970 DOLLARS/KILOWATT) (FACTOR
FOR ELECTRICAL DISTRIBUTION, FIELD INSTAL-
LATION COSTS IN NORMAL RANGE)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 117,947 KWATT

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS SYSTEM CONTAINS NO POWER GENERATING CAPACITY. SYSTEM COSTS REPRESENT ONLY CAPITAL REQUIREMENTS FOR POWER DISTRIBUTION.

COMPUTATION METHOD:

TOTAL SYSTEM COST = KILOWATT REQUIREMENT x TOTAL DIRECT COST FACTOR x
(1 + INDIRECT COST FACTOR) x ESCALATION FACTOR

INPUTS:

KILOWATT REQUIREMENT = 117,947 kw
TOTAL DIRECT COST FACTOR = \$102.62 (1970 DOLLARS/PER KILOWATT)
INDIRECT COST FACTOR = 0.469 (BASED ON 0.72 L/M RATIO)
ESCALATION FACTOR = 1.988 (FROM 1970 TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$35.347 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK PROCESS, SYSTEM NO. 14, PLANT POWER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 35.347	\$ 35.347	\$ 35.347	\$ 35.347
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 35.347	\$ 35.347	\$ 35.347	\$ 35.347

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK

SYSTEM: 15-STEAM GENERATION/DISTRIBUTION

UNIT OPERATION NUMBER: 84

SUBSYSTEM: DISTRIBUTION

REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL, p. 365

REFERENCE SYSTEM COST: TOTAL DIRECT COST FACTOR = 1.68 (1970 DOLLARS PER LBS PER HR)

REFERENCE CAPACITY: N/A

TVA CAPACITY: STEAM REQUIREMENT = 775,000 LB/HR.

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

SYSTEM DESIGN DOES NOT REQUIRE ANY INDEPENDENT STEAM GENERATION CAPACITY. SYSTEM COSTS REPRESENT DISTRIBUTION REQUIREMENTS INCLUDING PIPING, TRAPS, AND SUPERHEATERS.

COMPUTATION METHOD:

TOTAL SYSTEM COST = STEAM REQUIREMENT x TOTAL DIRECT COST FACTOR x (1 + INDIRECT COST FACTOR) x ESCALATION FACTOR

INPUTS:

STEAM REQUIREMENT = 775,000 LB/HR
TOTAL DIRECT COST FACTOR = \$1.68 (1970 DOLLARS/PER LBS/HR)
INDIRECT COST FACTOR = 0.488 (BASED ON AN L/M RATIO OF 0.82)
ESCALATION FACTOR = 1.988 (TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$3.852 x 10⁶ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK PROCESS, SYSTEM NO. 15, STEAM GENERATION/DISTRIBUTION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL: _____	\$ 3.852	\$ 3.852	\$ 3.852	\$ 3.852
TOTAL PROCESS CONTINGENCY.				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL: _____	-0-	-0-	-0-	-0-
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 3.852	\$ 3.852	\$ 3.852	\$ 3.852

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 16-WATER SUPPLY
UNIT OPERATION NUMBER: 85
SUBSYSTEM: BOILER FEEDWATER TREATING (RESIN DEMIN)
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
(SEE BELOW)
REFERENCE SYSTEM COST: 3,115,000 (JANUARY '80 DOLLARS) (TOTAL
DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 400qpm (DESIGN)
RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

1. SUBSYSTEM CONSISTS OF 2 PARALLEL TRAINS TO ALLOW FOR REGENERATION OF 1 TRAIN WHILE THE OTHER TRAIN IS ON STREAM. ASSUMED THE SUBSYSTEM WILL SUPPLY BFW FOR 1 MODULE. INCLUDES INSTALLED SKID MOUNTED CATION, ANION & MIXED RESIN BEDS, PUMPS, INTERCONNECT PIPING, VALVES, INSTRUMENTS, AND DEAERATOR.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS:		
DEMIN EQUIPMENT COST	=	\$1,930,000
INSTALLATION COST	=	\$ 960,000
REGEN STORAGE TANK COST	=	\$ 62,000 (INSTALLED) 2-5000 GAL TANKS (C.S)
FILTERS (PRESSURE)	=	\$ 163,000
		<u>\$3,115,000</u> JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)

INDIRECT COST FACTOR: 0.37 (ASSUMED .365 L/M RATIO FOR CHEMICAL PROCESS)

RESULTS:

TOTAL SYSTEM COST = \$4,267,550 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 16-WATER SUPPLY
UNIT OPERATION NUMBER: 85
SUBSYSTEM: BULK WATER TREATING
REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATED DESIGN EQUIPMENT COSTS (SEE BELOW)
REFERENCE SYSTEM COST: \$.880 x 10⁶ JANUARY '80 DOLLARS (TOTAL DIRECT COSTS) - SEE BELOW
REFERENCE CAPACITY: N/A
TVA CAPACITY: 4,000 (DESIGN)
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

$$\text{TOTAL SYSTEM COST} = \text{TOTAL DIRECT COSTS} \times (1 + \text{INDIRECT COST FACTOR})$$

INPUTS:

TOTAL DIRECT COSTS:

1.	FIREWATER POND - DIKED CLAY LINED (EXCL. LAND)	\$192,000
2.	CLARIFIER-SOFTENER - 76'-0" EQUIPMENT	293,000
	INSTALLATION	287,000
3.	CHEMICAL FEED SYSTEM (INC. PUMPS & MIX TANKS)	
	POLYMER	18,000
	LIME	50,000
4.	RECARBONATION (ASSUME LIQUID CO ₂ FEED SYSTEM)	40,000
	TOTAL	\$880,000

INDIRECT COST FACTOR = 0.37 (ASSUME .365 L/M RATIO FOR CHEMICAL PROCESS)

RESULTS:

$$\text{TOTAL SYSTEM COST} = \$1.190 \times 10^6 \text{ (JANUARY '80 DOLLARS)}$$

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK PROCESS, SYSTEM NO. 16, WATER SUPPLY

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>	<u>FACILITY TOTAL</u>
TOTAL DIRECT PLUS INDIRECT COSTS					
SUBSYSTEM-BULK WATER TREATING	\$ 1.190	\$ 1.190	\$ 1.190	\$ 1.190	
SUBSYSTEM-BOILER FEEDWATER TREATING	\$ 4.268	\$ 4.268	\$ 4.268	\$ 4.268	
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
<u>SYSTEM SUBTOTAL:</u>	\$ 5.458	\$ 5.458	\$ 5.458	\$ 5.458	
TOTAL PROCESS CONTINGENCY:					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
SUBSYSTEM NO. _____					
<u>SYSTEM SUBTOTAL:</u>	-0-	-0-	-0-	-0-	
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 5.458	\$ 5.458	\$ 5.458	\$ 5.458	\$ 5.458

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 17-COOLING WATER SYSTEM
UNIT OPERATION NUMBER: 39
SUBSYSTEM: UTILITY COOLING TOWER
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST ESTIMATE
REFERENCE SYSTEM COST: $\$3.5 \times 10^6$ JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 60,000 GPM
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS COST REFLECTS A REDUCTION IN COOLING TOWER CAPACITY FROM 75,000 IN TASK 5.2.1 TO 60,000 ABOVE.

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS = $\$3.5 \times 10^6$ (JANUARY '80 DOLLARS)
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)

RESULTS:

TOTAL SUBSYSTEM COST = $\$4.76 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 17-COOLING WATER SYSTEM
UNIT OPERATION NUMBER: 39
SUBSYSTEM: BLOWDOWN TREATMENT
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST ESTIMATE
REFERENCE SUBSYSTEM COST: \$932,617 JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 46 gpm
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:

SUBSYSTEM CONSISTS OF 1 VAPOR COMPRESSION SUPPORTER
(INSTALLED) = \$932,617

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS: \$932,617 JANUARY '80 DOLLARS
INDIRECT COST FACTOR: 0.36 (ASSUMED "NORMAL" .36 L/M RATIO FOR MIXED PROCESS)

RESULTS:

TOTAL SUBSYSTEM COST = \$1,268,359 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPE^{RS}-TOTZEK
SYSTEM: 17-COOLING WATER SYSTEM
UNIT OPERATION NUMBER: 39
SUBSYSTEM: GASIFIER COOLING TOWER
REFERENCE SOURCE FOR COSTING: SEE BELOW
REFERENCE SUBSYSTEM COST: N/A
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THIS ITEM IS TO BE DELETED FROM TASK 5.2.4 COST ESTIMATE, AS THIS GASIFIER COOLING TOWER IS INCLUDED IN SYSTEM 2.

COMPUTATION METHOD: N/A
INPUTS: N/A
RESULTS: N/A

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK PROCESS, SYSTEM NO. 17, COOLING WATER SYSTEM SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM GASIFIER COOLING TOWER	\$ 4.76	\$ 4.76	\$ 4.76	\$ 4.76
SUBSYSTEM NO. BLOWDOWN TREATMENT	\$ 1.268	\$ 1.268	\$ 1.268	\$ 1.268
<u>SUBTOTAL:</u>	\$ 6.028	\$ 6.028	\$ 6.028	\$ 6.028
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 6.028	\$ 6.028	\$ 6.028	\$ 6.028

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 18-WASTE WATER TREATMENT
UNIT OPERATION NUMBER: 33
SUBSYSTEM: PROCESS CONDENSATE TREATMENT
REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATE
REFERENCE SUBSYSTEM COST: \$.152 x 10⁶ JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 19,300 GAL/HR.
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS: \$.152 x 10⁶ (JANUARY '80 DOLLARS)
INDIRECT COST FACTOR: 0.37 (ASSUME .365 L/M RATIO FOR CHEMICAL PROCESS)

RESULTS:

TOTAL SUBSYSTEM COST = \$208,240 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK PROCESS, SYSTEM NO. 18, WASTE WATER TREATMENT

SUBSYSTEM INVESTMENT/AGGREGATION TABLE

ITEM DESCRIPTION	KOPPERS 33-PROCESS CONDENSATE TREATMENT				MODULE 4	FACILITY TOTAL
	MODULE 1	MODULE 2	MODULE 3	MODULE 4		
TOTAL DIRECT PLUS INDIRECT COSTS						
UNIT OPERATION: 33-PROCESS						
CONDENSATE TREATMENT						
SYSTEM SUBTOTAL:	\$.208	\$.208	\$.208	\$.208	\$.832	\$.832
TOTAL PROCESS CONTINGENCY:						
SUBSYSTEM NO. _____						
SUBSYSTEM NO. _____						
SUBSYSTEM NO. _____						
SUBSYSTEM NO. _____						
SUBSYSTEM NO. _____						
SYSTEM SUBTOTAL:	-0-	-0-	-0-	-0-	-0-	-0-
TOTAL SYSTEM CAPITAL INVESTMENT:	\$.208	\$.208	\$.208	\$.208	\$.832	\$.832

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK
SYSTEM: 19-GENERAL FACILITIES (BLDG & SUPPORT)
UNIT OPERATION NUMBER: 88
SUBSYSTEM:
REFERENCE SOURCE FOR COSTING: EVALUATION OF INTERMEDIATE - BTU COAL
GASIFICATION SYSTEMS FOR RETROFITTING
POWER PLANTS, EPRI AF-531, AUGUST 1977
REFERENCE SYSTEM COST: SEE BELOW
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:

INVESTMENT FOR SERVICE FACILITIES SUCH AS MAINTENANCE SHOPS, STORES, COMMUNICATIONS, SECURITY, AND OFFICES IS ESTIMATED AT 4.9% OF DIRECT INVESTMENT. THIS ESTIMATE WAS PREPARED BY TVA BASED ON THEIR CONSTRUCTION EXPERIENCE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT SYSTEM INVESTMENTS x (.049)

WHERE

1. TOTAL DIRECT COSTS = TOTAL SYSTEM CAPITAL INVESTMENT-INDIRECT COSTS
2. = TSCI - TDSI x INDIRECT COST FACTOR
3. = $\frac{1}{(1 + \text{INDIRECT COST FACTOR})} \times \text{TSCI}$

INPUTS:

INDIRECT COST FACTOR: 0.36 (ASSUMED "NORMAL" L/M RATIO)
SUBTOTAL FOR TOTAL SYSTEM CAPITAL INVESTMENT = $\$1258.626 \times 10^6$
(JANUARY '80 DOLLARS) (EXCLUDING BUILDING & SUPPORT)

RESULTS:

TOTAL DIRECT COSTS = $\$1,258.626 \times 10^6 \times .74$
= 931.383×10^6
TOTAL SYSTEM COST = $\$45.638 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK PROCESS, SYSTEM NO. 19, GENERAL FACILITIES (BLDG & SUPPORT)

SYSTEM CAPITAL INVESTMENT TABLE

GENERAL FACILITIES

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS
SUBTOTAL:

\$ 45.638

TOTAL PROCESS CONTINGENCY:
SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 45.638

THE BDM CORPORATION

b. Koppers-Totzek "Instant Plant" Capital Costs

THE BDM CORPORATION

FACILITY INVESTMENT AGGREGATION TABLE
KOPPERS-TOTZEK PROCESS
MILLIONS (10⁶) JANUARY '80 DOLLARS

ITEM DESCRIPTION	SYSTEM NO.	MODULE 1	MODULE 2	MODULE 3	MODULE 4	GENERAL FACILITIES	TOTAL
SYSTEM CAPITAL INVESTMENT							
COAL PREPARATION & FEEDING	1	86.604	86.604	86.604	86.604		346.416
GASIFICATION	2						
INITIAL GAS CLEANUP & COOLING	3						
ACID GAS REMOVAL	4	20.088	20.088	20.088	20.088		80.352
SULFUR RECOVERY & TAILGAS TREATMENT	5	26.373	13.186	13.186	13.186		65.931
AIR SEPARATION	6	74.700	73.600	73.600	73.600		295.500
COMPRESSION	7	22.638	22.638	22.638	22.638		90.552
PROCESS SOLIDS TREATMENT(DEWATERING)	8	.860	.860	.860	.860		3.440
INCINERATION	9	-0-	-0-	-0-	-0-		-0-
INSTRUMENTATION & CONTROL	10	4.669	4.669	4.669	4.669		18.676
SOLIDS WASTE RECYCLING/DISPOSAL	11	21.494	21.494	21.494	21.494		85.976
COAL HANDLING	12					64.214	64.214
BYPRODUCTS PROCESSING	13	1.000	1.000	1.000	1.000		4.000
PLANT POWER SYSTEM	14	35.347	35.347	35.347	35.347		141.388
STEAM GENERATION/DISTRIBUTION	15	3.852	3.852	3.852	3.852		15.408
WATER SUPPLY	16	5.458	5.458	5.458	5.458		21.832
COOLING WATER SYSTEM	17	6.028	6.028	6.028	6.028		24.112
WASTE WATER TREATMENT	18	.208	.208	.208	.208		.832
GENERAL FACILITIES (BLDG & SUPPORT)	19					45.638	45.638
SUBTOTAL (LESS BLDG & SUPPORT)							1258.629
(1) TOTAL SYSTEM CAPITAL INVESTMENT*		309.319	295.032	295.032	295.032	109.852	1304.267
(2) PROJECT CONTINGENCY 15 %		46.398	44.255	44.255	44.255	16.478	195.641
[15% OF (1)]							
(3) CONTRACTOR'S FEE 4 %		14.229	13.571	13.571	13.571	5.053	59.995
[4% OF (1) + (2)]							
(4) OWNER'S COSTS 2 %		7.399	7.057	7.057	7.057	2.628	31.198
[2% OF (1)+(2)+(3)]							
TOTAL FACILITY INVESTMENT		377.345	359.915	359.915	359.915	134.011	1591.101
[(1)+(2)+(3)+(4)]							
* INCLUDES PROCESS CONTINGENCIES WHICH							
TOTAL:		16.302	14.582	14.582	14.582	-0-	60.048
TOTAL SYSTEM CAPITAL INVESTMENT LESS		293.017	280.450	280.450	280.450	109.852	1244.219
CONTINGENCY							

THE BDM CORPORATION

OTHER CAPITALIZED COSTS AND WORKING CAPITAL KOPPERS-TOTZEK PROCESS MILLIONS OF JANUARY '80 DOLLARS

ITEM DESCRIPTION	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>	<u>GENERAL FACILITIES</u>	<u>TOTAL</u>
A. <u>OTHER CAPITALIZED COSTS</u>						
PAID-UP ROYALTIES 0.5 % OF TFI	1.887	1.80	1.80	1.80	.670	7.957
START-UP AND TESTING	84.856	84.856	84.856	84.856		339.424
ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION	83.563	79.992	79.992	79.992	28.833	352.372
SUBTOTAL OF OTHER CAPITALIZED COSTS	<u>170.306</u>	<u>166.648</u>	<u>166.648</u>	<u>166.648</u>	<u>29.503</u>	<u>699.753</u>
B. <u>WORKING CAPITAL</u>						
INITIAL CHARGE OF CATALYSTS AND CHEMICALS	.600	.600	.600	.600		2.400
MATERIALS INVENTORIES	4.141	4.141	4.141	4.141		16.564
SPARE PARTS INVENTORIES	1.705	1.626	1.626	1.626	0.606	7.189
MINIMUM CASH BALANCE	12.683	12.683	12.683	12.683		50.732
SUBTOTAL WORKING CAPITAL	<u>19.129</u>	<u>19.050</u>	<u>19.050</u>	<u>19.050</u>	<u>0.606</u>	<u>76.885</u>

LAND REQUIREMENTS

KOPPERS-TOTZEK PROCESS

SYSTEM #	LAND UNIT	DIMENSIONS	AREA PER UNIT	\$/ACRE OR \$/FT ²	UNITS PER SYSTEM	TOTAL AREA PER SYSTEM, ACRES	TOTAL COST
	2	W	FT ²	ACRES			
SUBTOTAL LAND REQUIREMENT					300		\$ 900,000
LAND SURVEY AND FEES*							\$ 4,000
FIRE CONTROL*							\$ 260,000
ALLOWANCE FOR INTERCONNECTIONS, SITE PREPARATION, MISCELLANEOUS*					300		\$2,430,000
SUBTOTAL DEPRECIABLE LAND RELATED EXPENSES							\$2,694,000

* COSTS OBTAINED FROM MITTELHAUSER GUIDE TO ESTIMATE TOTAL CAPITAL REQUIREMENT FOR PROCESSING FACILITIES

THE BDM CORPORATION

TOTAL CAPITAL REQUIREMENTS KOPPERS-TOTZEK PROCESS MILLIONS OF JANUARY '80 DOLLARS

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4	GENERAL FACILITIES	TOTAL
TOTAL FACILITY INVESTMENT	377.345	355.915	359.915	359.915	134.011	1591.101
OTHER CAPITALIZED COSTS	170.306	166.648	166.648	166.648	29.503	699.753
LAND RELATED COSTS					2.694	2.694
SUBTOTAL DEPRECIABLE INVESTMENT	<u>547.651</u>	<u>526.563</u>	<u>526.563</u>	<u>526.563</u>	<u>166.208</u>	<u>2293.548</u>
WORKING CAPITAL	19.129	19.050	19.050	19.050	0.606	76.885
LAND					0.900	.900
SUBTOTAL NON-DEPRECIABLE INVESTMENT	<u>19.129</u>	<u>19.050</u>	<u>19.050</u>	<u>19.050</u>	<u>1.506</u>	<u>77.785</u>
TOTAL CAPITAL REQUIREMENTS	<u>566.780</u>	<u>545.613</u>	<u>545.613</u>	<u>545.613</u>	<u>167.714</u>	<u>2371.333</u>

THE BDM CORPORATION

c. Koppers-Totzek Operations and Maintenance Costs

THE BDM CORPORATION

MODULE OPERATIONS MANPOWER STAFFING REQUIREMENTS* KOPPERS-TOTZEK

SYSTEM NO.	OPERATORS PER SHIFT	SHIFTS PER WEEK	UTILITY MEN PER SHIFT	SHIFTS PER WEEK	UNIT SUPVS PER SHIFT	SHIFTS PER WEEK	TOTAL HOURS PER YEAR
1	1 (\$21,600/yr)	5	1 (\$14.50/hr)	5	1 (\$34,500/yr)	5	6,240.
2	2 (\$14.00/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	8,320.
3	1 (\$13.00/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	6,240.
4	1 (\$21,600/yr)	5	1 (\$14.50/hr)	5	- INCLUDED IN UNIT 1 -	1	4,160.
5	-----	-----	INCLUDED IN UNIT 8	-----	-----	-----	-----
6	0	0	1 (\$15,200/yr)	7	-----INCLUDED IN UNIT 14----	-----	2,912.
7	1 (\$17,900/yr)	21	1 (\$13,100/yr)	7	1 (\$27,600/yr)	21	20,384.
8	1 (\$17,900/yr)	21	1 (\$13,100/yr)	21	1 (\$27,600/yr)	5	19,552.
9	-----	-----	INCLUDED IN UNIT 7	-----	-----	-----	-----
10	2 (\$17,900/yr)	21	-----	-----	INCLUDED IN UNIT 7	-----	17,472.
11	0**(\$17,900/yr)	21	1**(\$16,400/yr)	21	-----INCLUDED IN UNIT 12----	-----	8,736.
12	2**(\$20,300/yr)	21	2**(\$16,400/yr)	21	1 (\$27,600/yr)	21	43,680.
13	-----	-----	INCLUDED IN UNIT 12	-----	-----	-----	-----
14	1 (\$20,300/yr)	21	1 (\$16,400/yr)	7	1 (\$27,600/yr)	5	13,728.
15	1 (\$17,900/yr)	21	-----	-----	INCLUDED IN UNIT 3	-----	8,736.
16	-----	-----	INCLUDED IN UNIT 12	-----	-----	-----	-----
17	1 (\$17,900/yr)	21	0	0	1 (27,600/yr)	5	10,816.
18	1 (\$17,900/yr)	21	0	0	-----INCLUDED IN UNIT 14-----	-----	8,736.
19	-----	-----	INCLUDED IN UNIT 8, IF REQUIRED	-----	-----	-----	-----
					TOTALS		179,712.

* TOTAL STAFF = TOTAL STAFF $\frac{\text{HRS}}{\text{YR}} \div \frac{\text{PERSON-HRS}}{\text{YR}} = 179,712 \div 2080 = 86.4$ (USE 86 OR 87 PERSONS)

** DEPENDENT ON GASIFICATION TECHNOLOGY USED. (NUMBER OF GASIFIERS & FEED SYSTEMS PER MODULE AND RELATIVE ATTENTION REQUIRED.)

THE BDM CORPORATION

OPERATING REQUIREMENTS FOR EXPECTED OPERATIONS KOPPERS PROCESS

	BASIS	UNITS
Raw Materials		
Coal	TPY @ 100% Operation	1,825,000 TPY
Catalyst and Chemical Makeup	@ 100% Operation	280,200 \$/Yr
Initial Charge of Catalysts & Chemicals		\$ 600,000
Utility Requirements		
Water		3,200 gpm
Import Power	Kwh/Yr @ 100% Operation	929,896,300 Kw-Hr/Yr
Steam		
Operating Requirements		
Labor:		
Supervisors	mh/Yr	29,952
Operators	mh/Yr	148,760
Supplies	Factored as 15% of operating labor costs	
Maintenance Requirements		
Labor	Factored as 1.5% of total depreciable direct investment	
Supplies	Factored as 2.4% of total depreciable direct investment	
General Plant Staff	Factored as 30% of operating labor and maintenance labor & supervision	
Administration and Plant Overhead	Factored as 5% of operations & maintenance less feedstock and chemicals	
TOTAL NET MBG YIELD	(@ 100%)	25,022,940 MBTU/YEAR

THE BDM CORPORATION

ANNUAL MODULE OPERATING COSTS FOR EXPECTED OPERATIONS

KOPPERS-TOTZEK PROCESS MILLIONS OF JANUARY 1980 DOLLARS

<u>ITEM DESCRIPTION</u>	<u>UNITS</u>	<u>NET REQUIREMENTS</u>	<u>ANNUAL REQUIREMENTS</u>	<u>COST PER UNIT</u>	<u>ANNUAL COST (x 10⁶)</u>
FEEDSTOCK: (KENTUCKY #9 SEAM, DEEP MINE)*	MMBTU	1.098 x 10 ⁵ MMBTU/DAY	3.607 x 10 ⁷ MMBTU/YEAR	\$1.25	\$45.087
CATALYST & CHEMICAL MAKE-UP SUBTOTAL FEEDSTOCK & CATALYST & CHEMICALS					.252 <u>\$45.339</u>
ELECTRIC POWER - PK/AVG. LOAD FACTOR = 1.5	KWH	106,152.5 KWH/HR.	836,906,670 KWH/YEAR	\$.027	22.596
WATER	10 ³ GALLONS	4.608 x 10 ⁶ GALLONS/DAY	1513.728 x 10 ⁶ GALLONS/YR	\$.80/ K GAL	\$ 1.211
OPERATING LABOR	PERSON HRS.	149,760 HRS/YEAR	149,760 HRS/YEAR	\$12.11	\$ 1.813
OPERATING SUPPLIES	(15% OF OPERATING LABOR)				\$.272
MAINTENANCE LABOR	(1.6% OF 1/4 OF TFI)				\$ 6.364
MAINTENANCE SUPPLIES	(2.4% OF 1/4 OF TFI)				\$ 9.547
SUPERVISION	PERSON HRS.		29,952 HRS./YEAR	\$18.83	\$.564
GENERAL PLANT STAFF	(30% OF O.L. AND M.L. AND SUP)				\$ 2.622
ADMINISTRATION AND GENERAL OVERHEAD	(5% OF O&M LESS FEEDSTOCK AND CHEM.)				\$ 2.249
PROPERTY TAXES AND INSURANCE	DESIGN CRITERIA SPECIFY NO COSTS FOR THIS LINE ITEM				-0-
GROSS ANNUAL OPERATING & MAINTENANCE COSTS					\$47.238
BYPRODUCTS CREDITS					-0-
NET ANNUAL OPERATING & MAINTENANCE COSTS					<u>\$47.238</u>
TOTAL FEEDSTOCK, CAT & CHEM & O&M COSTS					<u>\$92.577</u>

* MEAN BTU VALUE OF FEEDSTOCK = 10,980 BTU/LB.

THE BDM CORPORATION

OPERATING COST DATA

PROCESS: KOPPERS-TOTZEK
ITEM: STAFFING REQUIREMENTS COSTS
REFERENCE: TVA DESIGN CRITERIA AND STAFFING NEEDS
 DEFINED BY BDM/MITTELHAUSER
METHOD: SYSTEM REQUIRES ONE MORE UTILITY PERSON
 THAN B&W DUE TO NUMBER OF GASIFIERS

<u>JOB DESCRIPTION</u>	<u>COMPENSATION RATE</u>	<u>HRS/YEAR</u>	<u>COST/YEAR</u>	<u>FRINGES</u>	<u>TOTAL</u>
<u>I. OPERATING LABOR</u>					
MECHANICAL UNIT					
FOREMAN	\$21,600/year	2,080	\$ 21,600	1.42	\$30,672
ELECTRICIAN	\$14.50/hr	2,080	\$ 30,160	0	30,160
COAL HANDLING					
FOREMAN	\$14.00/hr	4,160	\$ 58,240	0	58,240
LABORER	\$ 8.50/hr	4,160	\$ 35,360	0	35,360
HEAD OPERATOR	\$13.00/hr	2,080	\$ 27,040	0	27,040
INSTRUMENT UNIT					
FOREMAN	\$21,600/yr	2,080	\$ 21,600	1.42	30,672
INSTRUMENT					
MECHANIC	\$14.50/hr	2,080	\$ 30,160	0	30,160
CLASS C OPERATOR	\$15,200/yr	2,912	\$ 21,280	1.42	30,218
CLASS A OPERATOR	\$17,900/yr	61,152	\$526,260	1.42	747,289
PLANT LABORER	\$13,100/yr	11,648	\$ 73,360	1.42	104,171
CLASS B OPERATOR	\$16,400/yr	29,120	\$229,600	1.42	326,032
UNIT OPERATOR	\$20,300/yr	<u>26,208</u>	\$255,780	1.42	<u>363,208</u>
SUBTOTAL OPERATING LABOR		149,760			\$1,813,222
<u>II. SUPERVISION</u>					
PLANT OPERATING					
SUPERVISOR	\$34,500/year	2,080	\$ 34,500	1.42	\$ 48,990
YARD OPERATIONS					
SUPERVISOR	\$24,000/year	4,160	48,000	1.42	68,160
SHIFT ENGINEER	\$27,600/year	<u>23,712</u>	314,640	1.42	<u>446,789</u>
SUBTOTAL SUPERVISION		29,952			\$563,939
TOTAL STAFF REQUIREMENTS		179,712			\$2,377,161

THE BDM CORPORATION

d. Koppers-Totzek Present Value of Costs, Product Prices, and Cash Flow

THE BDM CORPORATION

PRESENT VALUE OF CAPITAL AND OPERATING AND MAINTENANCE COSTS						
MIDDEWS - TOTZEN						
MILLIONS OF DOLLARS						
ITEM DESCRIPTION	GENERAL FACILITY	MODULE 1	MODULE 2	MODULE 3	MODULE 4	TOTAL FACILITY
OPERATING AND MAINTENANCE EXPENSES						
FEEDSTOCK	0.00	496.95	477.68	468.11	458.81	1901.54
CATALYST & CHEMICALS	0.00	2.78	2.67	2.62	2.57	10.64
SUBTOTAL	0.00	499.72	480.35	470.73	461.38	1912.18
ELECTRIC POWER	0.00	223.81	213.82	209.06	204.66	851.35
WATER	0.00	4.86	4.34	4.09	3.87	17.16
OPERATING LABOR	0.00	18.61	17.88	17.52	17.16	71.17
OPERATING SUPPLIES	0.00	2.79	2.68	2.63	2.57	10.68
MAINTENANCE LABOR	0.00	67.08	64.40	63.08	61.82	256.38
MAINTENANCE SUPPLIES	0.00	100.61	96.60	94.62	92.72	384.57
SUPERVISION	0.00	5.79	5.56	5.45	5.34	22.13
GENERAL PLANT	0.00	26.92	25.85	25.33	24.82	102.92
ADMIN. & GENERAL	0.00	23.09	22.18	21.73	21.29	88.28
PROPERTY TAXES & INS	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL	0.00	473.57	453.31	443.50	434.26	1804.64
HYDROLYTIC REV	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL O&M COSTS	0.00	473.29	453.67	443.23	434.64	1716.82
CAPITAL COSTS						
DEPRECIABLE INVESTMENT COST	102.40	464.37	435.88	432.25	425.28	1900.26
NON-DEPRECIABLE INVESTMENT COST	1.30	13.54	13.17	12.61	12.70	53.31
SUBTOTAL CAPITAL COSTS	103.70	477.91	449.05	444.85	437.97	1953.57
TOTAL PRESENT VALUE OF CAPITAL AND OPERATIONS AND MAINTENANCE COSTS	103.70	1451.20	1382.72	1359.08	1333.61	5670.39
ANNUAL PRODUCT (MMBTU)	22520646, 22520646, 22520646, 22520646,					
PRODUCT PRICE (\$/MMBTU) (JANUARY 1980 DOLLARS)	\$ 6.64					
PRODUCT PRICE (\$/MMBTU) (CURRENT DOLLARS)	\$ 17.79					

THE BDM CORPORATION

KOPPERS - TOTZEK PROCESS FISCAL YEAR CASH FLOW SUMMARY - CONSTANT 1980 DOLLAR PRICE SCHEME

FISCAL YEAR	CAPITAL INVESTMENT	O&M	CAPITAL RECOVERY	TOTAL COSTS	REVENUE	CASH FLOW
1980	11.37	0.00	0.00	11.37	0.00	-11.37
1981	47.86	0.00	0.00	47.86	0.00	-47.86
1982	191.77	0.00	0.00	191.77	0.00	-191.77
1983	472.00	0.00	0.00	472.00	0.00	-472.00
1984	717.82	0.00	0.00	717.82	0.00	-717.82
1985	681.28	50.30	46.17	777.75	74.81	-702.94
1986	427.89	151.76	121.21	700.86	224.42	-476.44
1987	118.51	354.69	250.04	723.24	523.66	-199.58
1988	0.00	405.80	267.05	672.05	598.47	-73.58
1989	0.00	406.62	249.53	656.15	598.47	-57.68
1990	0.00	408.23	223.17	641.40	598.47	-42.93
1991	0.00	411.17	217.95	629.12	598.47	-30.65
1992	0.00	414.14	203.66	617.80	598.47	-19.33
1993	0.00	417.16	190.32	607.48	598.47	-9.01
1994	0.00	420.20	177.90	598.10	598.47	0.37
1995	0.00	423.29	166.27	589.56	598.47	8.91
1996	0.00	426.40	155.38	581.78	598.47	16.69
1997	0.00	427.47	145.22	572.69	598.47	25.78
1998	0.00	428.56	135.70	564.26	598.47	34.21
1999	0.00	429.66	126.83	556.49	598.47	41.98
2000	0.00	430.77	118.56	549.33	598.47	49.14
2001	0.00	431.90	110.80	542.70	598.47	55.77
2002	0.00	433.04	103.53	536.57	598.47	61.90
2003	0.00	434.19	96.77	530.96	598.47	67.51
2004	0.00	435.35	90.44	525.79	598.47	72.68
2005	0.00	381.96	72.59	454.55	523.66	69.11
2006	0.00	273.57	47.66	321.23	374.04	52.81
2007	0.00	54.86	9.21	64.07	74.81	10.74

All Figures in Millions of Fiscal 1980 Dollars

THE BDM CORPORATION

2. Texaco MBG

THE BDM CORPORATION

a. Texaco Systems Costs

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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 1 - COAL PREPARATION AND FEEDING

UNIT OPERATION NUMBER: 11

REFERENCE SOURCE: AF-642, CASE EXTC

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS SYSTEM IS COMBINED WITH SYSTEM 2 GASIFICATION IN THE REFERENCE SOURCE AF-642, EXTC. SEE SYSTEM 2, COSTING.

COMPUTATION METHOD: N/A

INPUTS: N/A

RESULTS: N/A

PRECEDING PAGE IS NOT FILMED

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 2 - GASIFICATION

UNIT OPERATION NUMBER: 20

REFERENCE SOURCE: EPRI AF-642, CASE EXTC (SLURRY FEED).
CATEGORY LISTED AS UNIT 20 - "GASIFICATION AND ASH HANDLING."

REFERENCE SYSTEM COST: \$24.261 X 10⁶ (MID '76 DOLLARS)

REFERENCE CAPACITY: 5 GASIFIERS PLUS 1 SPARE

TVA CAPACITY: 3 GASIFIERS PLUS 1 SPARE

RECOMMENDED CAPACITY EXPONENT: 1

EXPLANATORY COMMENTS:

1. FACTOR THE COMBINED TVA SYSTEMS 1 AND 2 TO THE REFERENCE DESIGN BY A LINEAR 4/6 FACTOR.
2. REFERENCE COST INCLUDES SYSTEM 1.

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE COST x CAPACITY FACTOR x
ESCALATION FACTOR

INPUTS:

REFERENCE COSTS = \$24.261 x 10⁶ (MID '76 DOLLARS)

CAPACITY FACTOR = 2/3

ESCALATION FACTOR = 1.30 (TO JANUARY 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$21.026 X 10⁶ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
TEXACO PROCESS, SYSTEM NO. 1, 2 - COAL PREPARATION, FEED, & GASIFICATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	MODULE 1	MODULE 2	MODULE 3	MODULE 4
TOTAL DIRECT PLUS INDIRECT COSTS				
<u>SUBTOTAL:</u>	\$21.026	\$21.026	\$21.026	\$21.026
TOTAL PROCESS CONTINGENCY - 15%				
<u>SUBTOTAL:</u>	3.154	3.154	3.154	3.154
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$24.180	\$24.180	\$24.180	\$24.180

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 3 - INITIAL GAS CLEAN-UP AND COOLING

UNIT OPERATION NUMBER: 21

REFERENCE SOURCE: GUTHRIE, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL.

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THE TVA/TEXACO GAS COOLING SYSTEM WAS DESIGNED AT THE EQUIPMENT LEVEL AND EACH MAJOR EQUIPMENT ITEM PRICED BASED UPON GUTHRIE, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL.
2. SEE ATTACHED PAGE #2 (FOR A LISTING OF ALL OF THE EQUIPMENT COSTS (MID 1978 DOLLARS))
3. AN EQUIPMENT LIST AND PROCESS FLOW DIAGRAM WILL BE INCLUDED IN THE REPORT WHICH GIVE THE NECESSARY DETAILS TO COST THESE ITEMS.

COMPUTATION METHOD: N/A

INPUT: N/A

RESULTS:

TOTAL SYSTEM COST = $\$13.816 \times 10^6$
(JANUARY 1980 DOLLARS)
(REFER TO FOLLOWING PAGES)

THE BDM CORPORATION

SYSTEM COST DATA

3 - INITIAL GAS CLEAN-UP AND COOLING

<u>Item</u>	<u>Type</u>	(B) (MID '78) Base Equipment Cost-Each	(E) (Mid '78) Equipment Cost-Each	<u>Number Required</u>
3-E-1	Shell & Tube Heat Exgr.	\$114,000	\$537,000	5
3-E-2	Shell & Tube Heat Exgr.	88,000	408,000	2
3-E-3	Shell & Tube Heat Exgr.	122,000	371,000	1
3-E-4	Air Cooled Heat Exgr.	137,000	449,000	4
3-E-5	Shell & Tube Heat Exgr.	59,000	153,000	1
3-V-1	Vertical Vessel	\$ 17,000	\$ 56,000	1
3-V-2	Vertical Vessel	15,000	50,000	1
3-V-3	Vertical Vessel	13,000	44,000	1
3-V-4	Vertical Vessel	12,500	41,000	1
3-V-5	Vertical Vessel	30,000	91,000	1
3-P-1	Centrifugal Pump & Motor	\$ 13,700	\$ 31,000	3
3-P-2	Centrifugal Pump & Motor	2,000	5,000	3
3-P-3	Centrifugal Pump & Motor	2,300	6,000	3
3-ME-1	Gas Scrubbing System	\$ 65,000	\$200,000	1

THE BDM CORPORATION

SUBSYSTEM COST DATA

3 - Initial Gas Clean-up & Cooling

ESTIMATE OF MODULAR EQUIPMENT COST
(Battery Limits or Offsite)

Equipment Number: 3-E-1-5

Category: Heat Exchangers Subsystems

Number of Units: (13 were included on the base and equipment price below)

Design Data:

Size
Duty
Etc. (Temp./Press)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : $\$1.475 \times 10^6$

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E [$E = B \times (F_{mt} \dots)$] $\$E \ 5.809 \times 10^6$

Field Materials

Piping	% x B	from diagrams
Concrete	"	
Steel	"	
Instruments	"	
Electrical	"	
Insulation	"	
Paint	"	

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Subtotal Field Materials (M) % x B	.848 of B	\$M	1.251
Total Direct Material (E+M)		<u>\$(E+M)</u>	<u>7.06</u>
Labor Component (L) % x B	.644 of B	\$L	<u>.95</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	8.01
Indirect Construction Costs % x B or (1+f) x B	.36 of (E+M+L)		<u>2.884</u>
			\$10.894 x 10 ⁶

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January '80 dollars 1.14

TOTAL MODULE COST, EQUIPMENT

\$12.419 x 10⁶

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SUBSYSTEM COST DATA

3 - Initial Gas Clean-up & Cooling

ESTIMATE OF MODULAR EQUIPMENT COST
(Battery Limits or Offsite)

Equipment Number: 3-V-1-5

Category: Vertical Vessels Subsystems

Number of Units (5 vertical vessels are included in prices below)

Design Data:

Size
Duty
Etc. (Temp./Press)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B: \$87,500

Adjustment Factors

Materials F_M

Temp. F_T

Pressure F_P

Size F_{Mag}

Purchased Equipment Cost E $[(E = B \times (F_{mt} \dots))]$ \$E 282,000

Field Materials

	% x B	from diagrams
Piping	"	
Concrete	"	
Steel	"	
Instruments	"	
Electrical	"	
Insulation	"	
Paint	"	

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Subtotal Field Materials (M) % x B	.761 of B	\$M	66,588
Total Direct Material (E+M)		<u>\$(E+M)</u>	<u>348,588</u>
Labor Component (L) % x B	.632 of B	\$L	<u>55,300</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	403,888
Indirect Construction Costs % x B or (1+f) x B	.36 of (E+M+L)		<u>145,400</u>
			<u>\$549,288</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January '80 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$0.626 \times 10^6$

THE BDM CORPORATION

SUBSYSTEM COST DATA

3 - Initial Gas Clean-up & Cooling

ESTIMATE OF MODULAR EQUIPMENT COST
(Battery Limits or Offsite)

Equipment Number: 13-P-1-3

Category: Centrifugal Pumps & Motor Subsystems

Number of Units: (9 pumps are included in tests below)

Design Data:

Size
Duty
Etc. (Temp./Press)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$54,000

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_P
Size	F_{Mag}

Purchased Equipment Cost E [$E = B \times (F_{mt} \dots)$] \$E 126,000

Field Materials

Piping	% x B	from diagrams
Concrete	"	
Steel	"	
Instruments	"	
Electrical	"	
Insulation	"	
Paint	"	

THE BDM CORPORATION

Subtotal Field Materials (M) % x B	.751 of B	\$M	40,554
Total Direct Material (E+M)		<u>\$(E+M)</u>	<u>166,554</u>
Labor Component (L) % x B	.71 of B	\$L	<u>38,340</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	204,894
Indirect Construction Costs % x B or (1+f) x B	.36 of (E+M+L)		<u>73,762</u>
			<u>\$278,656</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January '80 dollars 1.14

TOTAL MODULE COST, EQUIPMENT \$0.318 x 10⁶

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SUBSYSTEM COST DATA

3 - Initial Gas Clean-up & Cooling

ESTIMATE OF MODULAR EQUIPMENT COST
(Battery Limits or Offsite)

Equipment Number: 3-ME-1

Category: Gas Scrubbing Subsystem

Number of Units: 1

Design Data:

Size
Duty
Etc. (Temp./Press)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : 65,000

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_P
Size	F_{Mag}

Purchased Equipment Cost E [$E = B \times (F_{mt} \dots)$] \$E 200,000

Field Materials

Piping	% x B	from diagrams
Concrete	"	
Steel	"	
Instruments	"	
Electrical	"	
Insulation	"	
Paint	"	

THE BDM CORPORATION

Subtotal Field Materials (M) % x B	.761 of B	\$M	49,465
Total Direct Material (E+M)		<u>\$(E+M)</u>	249,465
Labor Component (L) % x B	.632 of B	\$L	<u>41,080</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	290,545
Indirect Construction Costs % x B or (1+f) x B	.36 of (E+M+L)		<u>104,596</u>
			<u>\$395,141</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January '80 dollars 1.14

TOTAL MODULE COST, EQUIPMENT \$450,460

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO PROCESS, SYSTEM NO. 3, INITIAL GAS CLEAN-UP AND COOLING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. HEAT EXCHANGERS	\$12.419	\$12.419	\$12.419	\$12.419
SUBSYSTEM NO. VERTICAL VESSELS	.626	.626	.626	.626
SUBSYSTEM NO. CENTRIFUGAL PUMPS	.318	.318	.318	.318
SUBSYSTEM NO. GAS SCRUBBER	.450	.450	.450	.450
<u>SUBTOTAL:</u>	13.813	13.813	13.813	13.813
TOTAL PROCESS CONTINGENCY: 5%				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$13.813	\$13.813	\$13.813	\$13.813

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO
SYSTEM: 4 - ACID GAS REMOVAL
SUBSYSTEM: ACID GAS REMOVAL (SELEXOL)
UNIT OPERATION NUMBER: 22
REFERENCE SOURCE: EPRI AF-916, CASE 4B
REFERENCE SYSTEM COST: \$54.227 X 10⁶ MID-1976 DOLLARS (3 TRAINS)
REFERENCE CAPACITY: 407,775 ACFH
TVA CAPACITY: 308,070 ACFH
RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

1. REFERENCE CAPACITY EQUALS 1/3 OF REFERENCE SOURCE DESIGN CAPACITY. THE REFERENCE SOURCE CONTAINS THREE PARALLEL TRAINS.
2. TVA REQUIRES ONE TRAIN.

COMPUTATION METHOD:

$$\text{TOTAL SYSTEM COST} = \frac{\text{EPRI TOTAL SYSTEM COST}}{3} \times \left(\frac{\text{TVA ACFH}}{\text{EPRI ACFH}} \right)^{0.6} \times \text{ESCALATION FACTOR}$$

INPUTS:

REFERENCE SYSTEM COST = \$54.227 X 10⁶ (MID-76 DOLLARS) (3 TRAINS)
COST OF SINGLE TRAIN = \$18.076 X 10⁶
CAPACITY FACTOR = $\left(\frac{308,070}{407,775} \right)^{0.6} = .845$
ESCALATION FACTOR = 1.30 (TO JANUARY '80 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$19.856 X 10⁶ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 4 - ACID GAS REMOVAL

SUBSYSTEM: PRODUCT GAS DEHYDRATION

UNIT OPERATION NUMBER: 22

REFERENCE SOURCE: FE-2447-13

REFERENCE SYSTEM COST: \$500,000 OCTOBER 1977 DOLLARS

REFERENCE CAPACITY: 16,304 LB MOL/HR

TVA CAPACITY: 29,575 LB MOL/HR

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. SYSTEM IS TYPICAL "GAS PLANT" TYPE TEG SYSTEM.
2. REFERENCE COST INCLUDES ALL INDIRECT COSTS EXCEPT ENGINEERING AND HOME OFFICE DESIGN.

COMPUTATION METHOD:

TOTAL SYSTEM COST = (REFERENCE SYSTEM COST + ENGINEERING AND HOME OFFICE COST) x ESCALATION FACTOR

INPUTS:

REFERENCE SYSTEM COST: $\$.500 \times 10^6$ (OCT. 1977 DOLLARS)

ENGINEERING AND HOME OFFICE COST: $\$.050 \times 10^6$ (OCT. 1977 DOLLARS)

ESCALATION FACTOR: 1.154 (TO JANUARY '80 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$.6347 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO PROCESS, SYSTEM NO. 4, ACID GAS REMOVAL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
ACID GAS REMOVAL (SELEXOL)	\$19.856	\$19.856	\$19.856	\$19.856
PRODUCT GAS DEHYDRATION	.635	.635	.635	.635
<u>SUBTOTAL:</u>	20.491	20.491	20.491	20.491
 TOTAL PROCESS CONTINGENCY: 5%				
<u>SUBTOTAL:</u>	1.025	1.025	1.025	1.025
 <u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$21.516	\$21.516	\$21.516	\$21.516

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO
SYSTEM: 5 - SULFUR RECOVERY & TAIL GAS TREATMENT
SUBSYSTEM: N/A
UNIT OPERATION NUMBER: 36
REFERENCE SOURCE: DOE REPORT FE-1775-18, PLANT 2
REFERENCE SYSTEM COST: \$9,032,000 MID-1977 DOLLARS
REFERENCE CAPACITY: 181.2 LT/D SULFUR PRODUCT
TVA CAPACITY: 165.2 LT/D SULFUR PRODUCT
RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

1. PROCESS NOTE: NORMAL OPERATING RATE OF PLANT 2 IS 240 M/H FEED ALTHOUGH DESIGN IS 527.5 M/H
2. PROVIDE 2 TRAINS FOR MODULE 1 (1 SPARE) and 1 TRAIN FOR EACH ADDITIONAL MODULE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST x INDIRECT CONSTRUCTION COSTS x CAPACITY FACTOR x ESCALATION FACTOR

CAPACITY FACTOR = $\left(\frac{\text{TVA CAP}}{\text{REF CAP}} \right)^{0.6}$

INPUTS:

REFERENCE SYSTEM COST: \$9.032 x 10⁶ (MID-1977 DOLLARS)

INDIRECT CONSTRUCTION COSTS: 1.10
(I.E. ENGINEERING AND HOME OFFICE)

CAPACITY FACTOR: $\left(\frac{165.2}{181.2} \right)^{0.6} = .946$

ESCALATION FACTOR: 1.22 (FROM MID-77 TO JANUARY '80 DOLLARS)

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RESULTS:

TOTAL SYSTEM COSTS (FOR
MODULES 2, 3, AND 4) =

$\$11.466 \times 10^6$ (JANUARY '80 DOLLARS)

TOTAL SYSTEM COST (FOR
MODULE 1) =

$\$22.933 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

TEXACO PROCESS, SYSTEM NO. 5, SULFUR RECOVERY AND TAIL GAS TREATMENT

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____	\$22.933	\$11.466	\$11.466	\$11.466
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	22.933	11.466	11.466	11.466
TOTAL PROCESS CONTINGENCY: 15%				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	3.440	1.720	1.720	1.720
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$26.373	\$13.186	\$13.186	\$13.186

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 6 - AIR SEPARATION

UNIT OPERATION NUMBER: 80

REFERENCE SOURCE: MITTELHAUSER INTERNAL COST DATA REPRESENTING A "COMPOSITE" OXYGEN PLANT BASED ON SEVERAL VENDORS, PLUS THE NECESSARY COMPRESSION COSTS (REFER TO ENCLOSED COST CURVES)

REFERENCE SYSTEM COST: $\$36 \times 10^6$ PER UNIT (10 REQUIRED)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 5 @ 1657 TPD OXYGEN (100%) PER UNIT @ 814.7 PSIA O₂

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

- (1) MODULES 1 AND 3 REQUIRE 3 UNITS EACH
- (2) MODULES 2 AND 4 REQUIRE 2 UNITS EACH

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE UNIT COST x NO. OF UNITS

INPUTS:

TOTAL INSTALLED COST = \$36,000,000 PER UNIT (JANUARY '80 DOLLARS)

RESULTS:

MODULES 1 AND 3 = $\$108.0 \times 10^6$ (JANUARY '80 DOLLARS)

MODULES 2 AND 4 = $\$72.0 \times 10^6$ (JANUARY '80 DOLLARS)

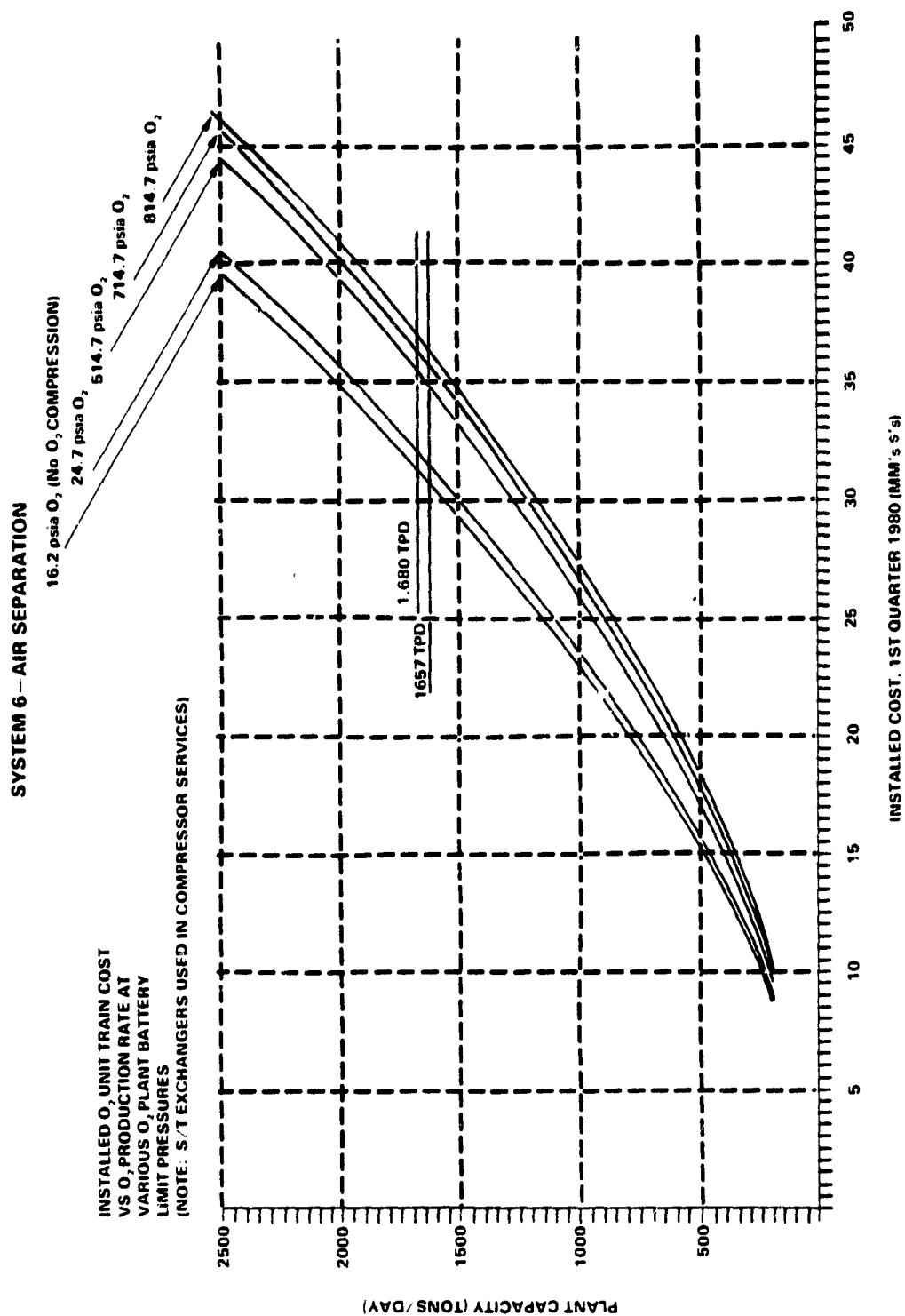


Figure III-1.1. Air Separation Plant Costs

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO PROCESS, SYSTEM NO. 6, AIR SEPARATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	MODULE 1	MODULE 2	MODULE 3	MODULE 4
TOTAL DIRECT PLUS INDIRECT COSTS				
<u>SUBTOTAL:</u>	\$108.0	\$72	\$108	\$72
TOTAL PROCESS CONTINGENCY:				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$108	\$72	\$108	\$72

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 8 - PROCESS SOLIDS TREATMENT (DEWATERING)

SUBSYSTEM: GASIFIER SLAG HANDLING

UNIT OPERATION NUMBER: 80

REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST DATA BASE

REFERENCE SYSTEM COST: \$513,000 JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 61,167 #/HR

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THIS SUBSYSTEM DOES NOT REQUIRE THE SAME EQUIPMENT AS THE KOPPERS-TOTZEK PROCESS.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS = \$513,000 (JANUARY '80 DOLLARS)

INDIRECT COST FACTOR: 0.335 (ASSUME .25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SYSTEM COST = \$684,855 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 8 - PROCESS SOLIDS TREATMENT (DEWATERING)

SUBSYSTEM: WATER TREATMENT SLUDGE HANDLING

UNIT OPERATION NUMBER: 31

REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST DATA BASE

REFERENCE SYSTEM COST: \$30,000 JANUARY '80 DOLLARS (TOTAL DIRECT COSTS) (SEE BELOW)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 1320 GAL/DAY OF 15% BY WEIGHT SLUDGE

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS:	2 LINED PONDS FOR GRAVITY DEWATERING	\$24,000
	25% CONTINGENCY FOR PUMPS	6,000
	TOTAL	\$30,000
	(JANUARY 1980 DOLLARS)	

INDIRECT COST FACTOR: 0.335 (ASSUME .25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SYSTEM COST = \$40,050 JANUARY '80 DOLLARS

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

TEXACO PROCESS, SYSTEM NO. 8, PROCESS SOLIDS TREATMENT (DEWATERING)

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. GASIFIER SLAG HANDLING	\$.685	\$.685	\$.685	\$.685
SUBSYSTEM NO. WATER TREATMENT	.040	.040	.040	.040
SLUDGE HANDLING	.725	.725	.725	.725
<u>SUBTOTAL:</u>				
TOTAL PROCESS CONTINGENCY	-0-	-0-	-0-	-0-
<u>SUBTOTAL:</u>				
TOTAL SYSTEM CAPITAL INVESTMENT:	\$.725	\$.725	\$.725	\$.725

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 10 - INSTRUMENTATION AND CONTROL

UNIT OPERATION NUMBER: N/A

REFERENCE SOURCE: GENERAL ELECTRIC ESTIMATE

REFERENCE SYSTEM COST: $\$1.5 \times 10^6$ JANUARY '80 DOLLARS (EQUIPMENT COST)

REFERENCE CAPACITY: REFERENCE COST BASED UPON A HONEYWELL 4500 SYSTEM

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THE SYSTEM CONTAINS JUST THE NECESSARY INSTRUMENTATION FOR THE CENTRALIZED REMOTE FACILITY. IT CONTAINS SUFFICIENT CABLE TO TRANSMIT SIGNALS FROM THE PROCESS UNITS, DATA PROCESSING EQUIPMENT, SOFTWARE PACKAGES FOR THE ANALYSIS OF INCOMING DATA, AND DISPLAY PANELS FOR PRESENTATION OF DATA. THIS SYSTEM DOES NOT INCLUDE LOCAL CONTROLS FOR DIRECT OPERATION OF INDIVIDUAL SYSTEMS.

COMPUTATION METHOD:

TOTAL DIRECT COST = $(1 + \text{INSTALLATION FACTOR}) \times \text{REFERENCE EQUIPMENT COST}$

TOTAL SYSTEM COST = $\text{TOTAL DIRECT COST} \times (1 + \text{INDIRECT COST FACTOR})$

INPUTS:

EQUIPMENT COST: $\$1.5 \times 10^6$ (JANUARY '80 DOLLARS)

INSTALLATION FACTOR: 1.10 (ASSUMED)

INDIRECT COST FACTOR: 1.289 (85/15 ASSUMED M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = $\$4.06 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO PROCESS, SYSTEM NO. 10, INSTRUMENTATION AND CONTROL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL: _____	\$4.06	\$4.06	\$4.06	\$4.06
TOTAL PROCESS CONTINGENCY: 15%				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL: _____	\$0.609	\$0.609	\$0.609	\$0.609
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	<u>\$4.669</u>	<u>\$4.669</u>	<u>\$4.669</u>	<u>\$4.669</u>

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 11 - SOLIDS WASTE RECYCLING/DISPOSAL

UNIT OPERATION NUMBER: 81

REFERENCE SOURCE: MITTELHAUSER ESTIMATE (FROM IN-HOUSE COST DATA BASE)

REFERENCE SYSTEM COST: $\$16.1 \times 10^6$ (JANUARY '80 DOLLARS) (TOTAL DIRECT COSTS - SEE BELOW)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 61,000 #/HR SOLIDS (DRY), 2319 GAL/HR H₂O WITH SOLIDS

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. SYSTEM IS ESSENTIALLY AN EXCAVATED 20 YEAR AREA FOR SOLID DISPOSAL. INCLUDES EXCAVATION AND CONSTRUCT OF CLAY LINED DISPOSAL AREA RUNOFF HOLDING POND.
2. LAND COSTS WERE NOT INCLUDED

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COST =	INSTALLED COST OF SOLIDS DISPOSAL AREA =	$\$10.0 \times 10^6$
	INSTALLED COST OF RUNOFF COLLECTION BASIN =	6.1×10^6
	(BOTH ARE LINED WITH CLAY LINER)	$\$16.1 \times 10^6$

INDIRECT COST FACTOR: 0.335 (ASSUMED .25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SYSTEM COST = $\$21.494 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

TEXACO PROCESS SYSTEM NO. 11, SOLIDS WASTE RECYCLING/DISPOSAL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. LINED DISPOSAL AREA	\$13.350	\$13.350	\$13.350	\$13.350
SUBSYSTEM NO. RUNOFF COLLECTION	8.144	8.144	8.144	8.144
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	21.494	21.494	21.494	21.494

TOTAL PROCESS CONTINGENCY:

SUBSYSTEM NO. _____	-0-	-0-	-0-	-0-
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

	\$ 21.494	\$ 21.494	\$ 21.494	\$ 21.494
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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 12 - COAL HANDLING

UNIT OPERATION NUMBER: 10

REFERENCE SOURCE: RESOURCE ENGINEERING INCORPORATED ESTIMATE BASED UPON IN-HOUSE COST DATA. SEE DETAILED EQUIPMENT WHICH FOLLOWS.

REFERENCE SYSTEM COST: $\$48.1 \times 10^6$ JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)

REFERENCE CAPACITY: 20,000 TPD

TVA CAPACITY: 20,000 TPD

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

FULL 20,000 TPD SYSTEM IS INSTALLED WITH THE FIRST MODULE. THIS SYSTEM WILL THEN SERVE THE ENTIRE FACILITY.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS: $\$48.1 \times 10^6$ (JANUARY '80 DOLLARS)

INDIRECT COST FACTOR: 0.335 (ASSUMED .25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SYSTEM COST = $\$64.214 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM 12 COAL HANDLING

<u>CAPITAL COST</u>	(E+M+L) January '80 <u>In Million Dollars</u>
<u>Description</u>	
1. Continuous barge unloader, elevator type, 3000-3500 TPH, including dock, moorings, surge bin, conveyors.	\$10.0
2. Open Coal storage piles, 1.8×10^6 tons, Double windows 100' high x (2 x 240') wide x 2800' costs for site preparation, stockpiling conveyors, stacker/reclaiming equipment, mobile equipment.	30.0
3. Rotary breakers, three (2N, 1S), 1000 TPH each, 50 hp each, 12'Ø x 22' each	1.0
4. Concrete silos, four, 11750 tons each, 67'Ø x 150' each	6.0
5. Truck dump hopper, 2000 tons	0.2
6. Conveyors not included above	
a. Truck station to crusher, 500 TPH 36" x 500 ft, 0 elevation, 426 fpm, 32 hp	0.3
b. Crusher to silos, 2160 TPH 60" x 700 ft, 150 ft elevation, 470 hp, 600 fmp	<u>0.6</u>
TOTAL DIRECT COSTS (E+M+L) =	\$48.1

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
TEXACO PROCESS, SYSTEM NO. 12, COAL HANDLING

SYSTEM CAPITAL INVESTMENT TABLE

GENERAL FACILITIES

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBTOTAL:

\$64.214

TOTAL PROCESS CONTINGENCY

SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$64.214

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SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 13 - BYPRODUCTS PROCESSING

SUBSYSTEM: SULFUR STORAGE AND LOADING

UNIT OPERATION NUMBER: 83

REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST DATA BASE

REFERENCE SYSTEM COST: $\$1 \times 10^6$ (JANUARY '80 DOLLARS)

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. BDM TO ESTIMATE FOR HEATED TANKAGE AND PRILL TOWER FOR 165 LTPD SULFUR PRODUCT.
2. ORDER OF MAGNITUDE ESTIMATE OF $\$1 \times 10^6$ BASED UPON FLAKING SULFUR STORAGE FACILITY RATHER THAN PRILL TOWER.

COMPUTATION METHOD: N/A

INPUTS:

REFERENCE SYSTEM COST = $\$1 \times 10^6$ (JANUARY '80 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$1 \times 10^6$ (JANUARY '80 DOLLARS FOR EACH MODULE)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
TEXACO PROCESS, SYSTEM NO. 13, BYPRODUCT PROCESSING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	MODULE 1	MODULE 2	MODULE 3	MODULE 4
TOTAL DIRECT PLUS INDIRECT COSTS				
<u>SUBTOTAL:</u>	\$1	\$1	\$1	\$1
TOTAL PROCESS CONTINGENCY:				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$1	\$1	\$1	\$1

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 14 - PLANT POWER SYSTEM

SUBSYSTEM: PLANT ELECTRICAL DISTRIBUTION

UNIT OPERATION NUMBER: 87

REFERENCE SOURCE: REQUIREMENTS FACTORED COST ESTIMATE FROM GUTHRIE, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL p. 363

REFERENCE SYSTEM COST: \$102.62 (1970 DOLLARS/KILOWATT) (FACTOR FOR ELECTRICAL DISTRIBUTION FIELD INSTALLATION COSTS IN NORMAL RANGE)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 88,000 KW

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = KILOWATT REQUIREMENT x TOTAL DIRECT COST FACTOR x (1 + INDIRECT COST FACTOR) x ESCALATION FACTOR

INPUTS:

KILOWATT REQUIREMENT (INCLUDING IMPORT AND INTERNAL GENERATION) = 88,000 KW

TOTAL DIRECT COST FACTOR = \$102.62 (1970 DOLLARS/PER KILOWATT)

INDIRECT COST FACTOR = 0.469 (BASED ON 0.72 L/M RATIO)

ESCALATION FACTOR = 1.988 (FROM 1970 BASE YEAR DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$26.373 x 10⁶ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 14 - PLANT POWER SYSTEM

SUBSYSTEM: TURBOGENERATOR FOR ON-SITE POWER FOR
I.P. STEAM

UNIT OPERATION NUMBER: 87

REFERENCE SOURCE: EQUIPMENT FACTORED COST ESTIMATE FROM
GUTHRIE, PROCESS PLANT ESTIMATING, EVAL-
UATION, AND CONTROL

REFERENCE SYSTEM COST: \$17,040,000 MID 1978 DOLLARS (EQUIPMENT
COST)

REFERENCE CAPACITY: 38,500 KW

TVA CAPACITY: 38,500 KW

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

MITTELHAUSER ESTIMATE FROM IN HOUSE COST DATABASE AS WELL AS
GUTHRIE, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL.

COMPUTATION METHOD:

TOTAL SYSTEM COST = EQUIPMENT COST x INSTALLATION FACTOR x
(1 + INDIRECT COST FACTOR) x ESCALATION
FACTOR

INPUTS:

EQUIPMENT COST: "POWER GENERATION FACILITY"
FOR 38,500 KW = \$22,560,000
MINUS
"FIELD ERECTED BOILER
COST" FOR 666,000 LB/HR
STEAM = 5,600,000
ESTIMATED EQUIPMENT COST \$17,040,000
(MID-1978
DOLLARS)

INSTALLATION FACTOR: 1.307

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INDIRECT COST FACTOR: 0.15 (ASSUMED)

ESCALATION FACTOR: 1.14 (FROM 1978 TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$29.198 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS PROCESS, SYSTEM NO. 14, PLANT POWER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. TURBO GENERATOR	\$29.198	\$29.198	\$29.198	\$29.198
SUBSYSTEM NO. DISTRIBUTION	26.373	26.373	26.373	26.373
<u>SUBTOTAL:</u>	55.571	55.571	55.571	55.571
TOTAL PROCESS CONTINGENCY				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$55.571	\$55.571	\$55.571	\$55.571

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO
SYSTEM: 15 - STEAM GENERATION/DISTRIBUTION
UNIT OPERATION NUMBER: 86
REFERENCE SOURCE: REQUIREMENTS FACTORED COST FROM GUTHRIE,
PROCESS PLANT ESTIMATING, EVALUATION AND
CONTROL p. 365.

REFERENCE SYSTEM COST:

TOTAL DIRECT COST FACTOR = 1.68 (1970 DOLLARS PER LBS PER HR)

REFERENCE CAPACITY: N/A

TVA CAPACITY: STEAM REQUIREMENT = 1,086,500 LBS/HR

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS SYSTEM ONLY CONTAINS EQUIPMENT FOR THE GENERAL DISTRIBUTION OF
BOILER FEED WATER, COLLECTION OF CONDENSATE, DEAERATION OF CONDENSATE,
AND MINIMAL SURGE STORAGE OF DEMINERALIZED WATER.

COMPUTATION METHOD:

TOTAL SYSTEM COST = STEAM REQUIREMENT x TOTAL DIRECT COST
FACTOR x (1 + INDIRECT COST FACTOR) x
ESCALATION FACTOR

INPUTS:

STEAM REQUIREMENT = 1,086,500 LB/HR
TOTAL DIRECT COST FACTOR = \$1.68 (1970 DOLLARS PER LBS/HR)
INDIRECT COST FACTOR = 0.488 (BASED ON .82 L/M RATIO)
ESCALATION FACTOR = 1.988 (BASED ON JANUARY '80 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$5.340 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO PROCESS, SYSTEM NO. 15, STEAM GENERATION/DISTRIBUTION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	MODULE 1	MODULE 2	MODULE 3	MODULE 4
TOTAL DIRECT PLUS INDIRECT COSTS				
<u>SUBTOTAL:</u>	\$5.340	\$5.340	\$5.340	\$5.340
TOTAL PROCESS CONTINGENCY				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$5.340	\$5.340	\$5.340	\$5.340

THE EGM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 16 - WATER SUPPLY

SUBSYSTEM: RAW WATER TREATMENT

UNIT OPERATION NUMBER: 85

REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST DATA BASE

REFERENCE SYSTEM COST: \$758,000 JANUARY '80 DOLLARS (TOTAL DIRECT COST)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 2533 GPM

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS =

FIRE WATER POND	\$164,000
CLARIFIER	503,000
CHEMICAL FEED SYSTEM	91,000
TOTAL DIRECT COSTS	\$758,000
(JANUARY '80 DOLLARS)	

INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = $\$1.031 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO
SYSTEM: 16 - WATER SUPPLY
UNIT OPERATION NUMBER: 85
SUBSYSTEM: BOILER FEED WATER TREATMENT
REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: \$918,000 JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 50 GPM
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS =	FILTER	\$ 47,000
	PARALLEL, SKID-MOUNTED	
	DEMINERALIZER TRAINS	833,000
	CHEMICAL STORAGE TANKS	38,000
	TOTAL DIRECT COSTS	<u>\$918,000</u>
		(JANUARY '80 DOLLARS)

INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = $\$1.248 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO PROCESS, SYSTEM NO. 16, WATER SUPPLY

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>GENERAL FACILITIES</u>		
TOTAL DIRECT PLUS INDIRECT COSTS			
SUBSYSTEM NO. RAW WATER TREATMENT	\$1.031	\$1.031	\$1.031
SUBSYSTEM NO. BOILER FEED WATER TREATMENT	1.248	1.248	1.248
<u>SUBTOTAL:</u>	2.279	2.279	2.279
TOTAL PROCESS CONTINGENCY			
<u>SUBTOTAL:</u>	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$2.279	\$2.279	\$2.279

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SYSTEM COST DATA

<u>PROCESS:</u>	TEXACO
<u>SYSTEM:</u>	17 - COOLING WATER SYSTEM
<u>UNIT OPERATION NUMBER:</u>	39
<u>SUBSYSTEM:</u>	COOLING TOWER
<u>REFERENCE SOURCE:</u>	MITTELHAUSER IN-HOUSE COST DATA BASE
<u>REFERENCE SYSTEM COST:</u>	\$4,200,000 JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	80,500 GPM
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	
TOTAL SUBSYSTEM COST =	TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)
<u>INPUTS:</u>	
TOTAL DIRECT COSTS:	$\$4.2 \times 10^6$ (JANUARY '80 DOLLARS)
INDIRECT COST FACTOR:	0.36 (ASSUME .25 L/M RATIO FOR MIXED PROCESSES)
<u>RESULTS:</u>	
TOTAL SUBSYSTEM COSTS =	\$5,712,000 (JANUARY '80 DOLLARS)

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SYSTEM COST DATA

PROCESS: TEXACO
SYSTEM: 17 - COOLING WATER SYSTEM
UNIT OPERATION NUMBER: 39
SUBSYSTEM: BLOWDOWN TREATMENT
REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST ESTIMATE
REFERENCE SYSTEM COST: \$852,000 JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 42 GPM
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:

SUBSYSTEM IS A VAPOR COMPRESSION EVAPORATOR.

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS: \$852,000 (JANUARY '80 DOLLARS)
INDIRECT COST FACTOR: 0.36 (ASSUME .25 L/M RATIO FOR MIXED PROCESSES)

RESULTS:

TOTAL SUBSYSTEM COST = \$1,158,720 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO PROCESS, SYSTEM NO. 17, COOLING WATER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. COOLING TOWER	\$5.712	\$5.712	\$5.712	\$5.712
SUBSYSTEM NO. BLOWDOWN TREATMENT	1.159	1.959	1.159	1.159
<u>SUBTOTAL:</u>	6.871	6.871	6.871	6.871
TOTAL PROCESS CONTINGENCY				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$6.871	\$6.871	\$6.871	\$6.871

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SYSTEM COST DATA

<u>PROCESS:</u>	TEXACO
<u>SYSTEM:</u>	18 - WASTE WATER TREATMENT
<u>SUBSYSTEM:</u>	PROCESS CONDENSATE TREATMENT
<u>UNIT OPERATION NUMBER:</u>	37
<u>REFERENCE SOURCE:</u>	EPA 600/2-78-182
<u>REFERENCE SYSTEM COST:</u>	\$28,000 JANUARY '80 DOLLARS
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	50 GPM
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	
TOTAL SYSTEM COST =	TOTAL DIRECT COST x (1 + INDIRECT COST FACTOR)
<u>INPUTS:</u>	
TOTAL DIRECT COST =	\$28,000 (JANUARY '80 DOLLARS)
CONSISTS OF:	PRESSURE LEAF FILTER CHEMICAL CLEANER PUMPS
INDIRECT COST FACTOR:	0.37 (ASSUME .365 L/M RATIO FOR CHEMICAL PROCESSES)
<u>RESULTS:</u>	
TOTAL SYSTEM COST =	\$38,360 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO PROCESS, SYSTEM NO. 18, WASTE WATER TREATMENT

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
<u>SUBTOTAL:</u>	\$0.038	\$0.038	\$0.038	\$0.038
TOTAL PROCESS CONTINGENCY				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$0.038	\$0.038	\$0.038	\$0.038

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SYSTEM COST DATA

PROCESS: TEXACO

SYSTEM: 19 - GENERAL FACILITIES (BLDG & SUPPORT)

UNIT OPERATION NUMBER: 88

REFERENCE SOURCE: EVALUATION OF INTERMEDIATE - BTU COAL GASIFICATION SYSTEMS FOR RETROFITTING POWER PLANTS EPRI AF-531, AUGUST 1977

REFERENCE SYSTEM COST: SEE BELOW

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

INVESTMENT FOR SERVICE FACILITIES SUCH AS MAINTENANCE SHOPS, STORES, COMMUNICATIONS, SECURITY AND OFFICES IS ESTIMATED AT 4.9% OF DIRECT INVESTMENT. THIS ESTIMATE WAS PREPARED BY TVA BASED ON THEIR CONSTRUCTION EXPERIENCE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT SYSTEM INVESTMENTS \times (.049)

where

(1) TOTAL DIRECT COSTS = TOTAL SYSTEM CAPITAL INVESTMENT - INDIRECT COSTS

(2) = TSCI-TDSI \times INDIRECT COST FACTOR

(3) = $\frac{1 \times \text{TSCI}}{(1 + \text{INDIRECT COST FACTOR})}$

INPUTS:

INDIRECT COST FACTOR: 0.36 (ASSUMED "NORMAL" L/M RATIO)

SUBTOTAL FOR TOTAL SYSTEM CAPITAL INVESTMENT (EXCLUDING BUILDING AND SUPPORT) =

\$1120.129 $\times 10^6$ (JANUARY '80 DOLLARS)

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RESULTS:

TOTAL DIRECT COSTS = $\$1120.129 \times 10^6 \times .74 = 828.895 \times 10^6$

TOTAL SYSTEM COST = $\$40.615 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS PROCESS, SYSTEM NO. 19, GENERAL FACILITIES (BLDG & SUPPORT)

SYSTEM CAPITAL INVESTMENT TABLE

GENERAL FACILITIES

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

\$40.615

SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBTOTAL: _____

40.615

TOTAL PROCESS CONTINGENCY

-0-

SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBTOTAL: _____

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$40.615

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b. Texaco "Instant Plant" Capital Costs

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FACILITY INVESTMENT AGGREGATION TABLE TEXACO PROCESS

MILLIONS (10⁶) JANUARY '80 DOLLARS

ITEM DESCRIPTION	SYSTEM NO.	MODULE 1	MODULE 2	MODULE 3	MODULE 4	GENERAL FACILITIES	TOTAL
SYSTEM CAPITAL INVESTMENT							
COAL PREPARATION & FEEDING	1						
GASIFICATION	2	24.180	24.180	24.180	24.180		96.720
INITIAL GAS CLEANUP & COOLING	3	13.813	13.813	13.813	13.813		55.252
ACID GAS REMOVAL	4	21.516	21.516	21.516	21.516		86.064
SULFUR RECOVERY & TAILGAS TREATMENT	5	26.373	13.186	13.186	13.186		65.931
AIR SEPARATION	6	108.000	72.000	108.000	72.000		360.000
COMPRESSION	7	-0-	-0-	-0-	-0-		-0-
PROCESS SOLIDS TREATMENT(DEWATERING)	8	.725	.725	.725	.725		2.900
INCINERATION	9	-0-	-0-	-0-	-0-		-0-
INSTRUMENTATION & CONTROL	10	4.669	4.669	4.669	4.669		18.676
SOLIDS WASTE RECYCLING/DISPOSAL	11	21.494	21.494	21.494	21.494		85.976
COAL HANDLING	12					64.214	64.214
BYPRODUCTS PROCESSING	13	1.000	1.000	1.000	1.000		4.000
PLANT POWER SYSTEM	14	55.571	55.571	55.571	55.571		222.284
STEAM GENERATION/DISTRIBUTION	15	5.340	5.340	5.340	5.340		21.360
WATER SUPPLY	16	2.279	2.279	2.279	2.279		9.116
COOLING WATER SYSTEM	17	6.871	6.871	6.871	6.871		27.484
WASTE WATER TREATMENT	18	.038	.038	.038	.038		.152
GENERAL FACILITIES (BLDG & SUPPORT)	19					40.615	40.615
SUBTOTAL (LESS BLDG & SUPPORT)							1120.129
(1) TOTAL SYSTEM CAPITAL INVESTMENT*		291.869	242.682	278.682	242.682	104.829	1160.744
(2) PROJECT CONTINGENCY 15 %		43.780	36.402	41.802	36.402	15.724	174.110
[15% OF (1)]							
(3) CONTRACTOR'S FEE 4 %		13.426	11.163	12.819	11.163	4.822	53.393
[4% OF (1) + (2)]							
(4) OWNER'S COSTS 2 %		6.981	5.805	6.666	5.805	2.508	27.765
[2% OF (1)+(2)+(3)]							
TOTAL FACILITY INVESTMENT		356.056	296.052	339.969	296.052	127.883	1416.012
* INCLUDES PROCESS CONTINGENCIES							
WHICH TOTAL:		8.228	6.508	6.508	6.508	-0-	-0-
TOTAL SYSTEM COST LESS CONTINGENCY		283.641	236.174	272.174	236.174	104.829	1132.992

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THE BDM CORPORATION

OTHER CAPITALIZED COSTS AND WORKING CAPITAL TEXACO PROCESS MILLIONS OF JANUARY '80 DOLLARS

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4	GENERAL FACILITIES	TOTAL
A. OTHER CAPITALIZED COSTS						
PAID-UP ROYALTIES 0.5% OF TFI	1.780	1.480	1.670	1.480	.639	7.049
START-UP AND TESTING	70.971	70.971	70.971	70.971	-0-	283.884
ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION	78.179	65.884	74.883	65.884	27.577	312.407
SUBTOTAL OF OTHER CAPITALIZED COSTS	<u>150.930</u>	<u>138.335</u>	<u>147.524</u>	<u>138.335</u>	<u>28.216</u>	<u>603.340</u>
B. WORKING CAPITAL						
INITIAL CHARGE OF CATALYSTS AND CHEMICALS	.607	.607	.607	.607	-0-	2.428
MATERIALS INVENTORIES	4.138	4.138	4.138	4.138	-0-	16.552
SPARE PARTS INVENTORIES	1.608	1.338	1.536	1.338	.578	6.398
MINIMUM CASH BALANCE	10.608	10.608	10.608	10.608	-0-	42.432
SUBTOTAL WORKING CAPITAL	<u>16.961</u>	<u>16.961</u>	<u>16.889</u>	<u>16.691</u>	<u>.578</u>	<u>67.810</u>

THE BDM CORPORATION

LAND REQUIREMENTS TEXACO PROCESS

SYSTEM #	LAND UNIT			DIMENSIONS		AREA PER UNIT		\$/ACRE OR \$/FT ²	UNITS PER SYSTEM	TOTAL AREA		TOTAL COST
	L	W	FT ²	ACRES	FT ²	ACRES	FT ²			PER SYSTEM, ACRES	ACRES	
SUBTOTAL LAND REQUIREMENT								\$3,000		300	300	\$ 500,000
LAND SURVEY AND FEES*												\$ 4,000
FIRE CONTROL*												\$ 260,000
ALLOWANCE FOR*												
INTERCONNECTIONS,												
SITE PREPARATION,												
MISCELLANEOUS*								\$8,100		360	360	\$2,430,000
SUBTOTAL DEPRECIABLE LAND RELATED EXPENSES												\$2,694,000

* COSTS OBTAINED FROM MITTELHAUSER GUIDE TO ESTIMATE TOTAL CAPITAL REQUIREMENT FOR PROCESSING FACILITIES

THE BDM CORPORATION

TOTAL CAPITAL REQUIREMENTS TEXACO PROCESS MILLIONS OF JANUARY '80 DOLLARS

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4	GENERAL FACILITIES	TOTAL
TOTAL FACILITY INVESTMENT	356.056	296.052	339.969	296.052	127.883	1416.012
OTHER CAPITALIZED COSTS	150.930	138.335	147.524	138.335	28.216	603.340
LAND RELATED COSTS					2.694	2.694
SUBTOTAL DEPRECIABLE INVESTMENT	506.986	434.387	487.493	434.387	158.793	2022.946
WORKING CAPITAL	16.961	16.961	16.889	16.691	.578	67.810
LAND					.900	.900
SUBTOTAL NON-DEPRECIABLE INVESTMENT	16.961	16.961	16.889	16.691	1.478	68.710
TOTAL CAPITAL REQUIREMENTS	523.947	451.078	504.382	451.078	160.271	2090.756

THE BDM CORPORATION

c. Texaco Operations and Maintenance Costs

THE BDM CORPORATION

TEXACO STAFFING REQUIREMENTS* MODULE OPERATIONS MANPOWER

SYSTEM NO.	OPERATORS PER SHIFT	SHIFTS PER WEEK	UTILITY MEN PER SHIFT	SHIFTS PER WEEK	UNIT SUPVS PER SHIFT	SHIFTS PER WEEK	TOTAL HOURS PER YEAR
1	1 (\$21,600/yr)	5	1 (\$14.50/hr)	5	1 (\$34,500/yr)	5	6,240
2	2 (\$14.00/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	8,320
3	1 (\$13.00/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	6,240
4	1 (\$21,600/hr)	5	1 (\$14.50/hr)	5	- INCLUDED IN UNIT 1 -	1 -	4,160
5			INCLUDED IN UNIT 8				
6	0	0	1 (\$15,200/yr)	7	- INCLUDED IN UNIT 14 -	14 -	2,912
7	1 (\$17,900/yr)	21	1 (\$13,100/yr)	7	1 (\$27,600/yr)	21	20,384
8	1 (\$17,900/yr)	21	1 (\$13,100/yr)	21	1 (\$27,600/yr)	5	19,552
9			INCLUDED IN UNIT 7				
10	2 (\$17,900/yr)	21	INCLUDED IN UNIT 1				17,472
11	(-)**(\$17,900/yr)	21	(1)**(\$16,400/yr)				8,736
12	(2)**(\$20,300/yr)	21	(1)**(\$16,400/yr)				34,944
13			INCLUDED IN UNIT 12				
14	1 (\$20,300/yr)	21	1 (\$16,400/yr)	7	1 (\$27,600/yr)	5	13,728
15	1 (\$17,900/yr)	21	INCLUDED IN UNIT 3				8,736
16			INCLUDED IN UNIT 12				
17	1 (\$17,900/yr)	21	0	0	1 (\$27,600/yr)	5	10,816
18	1 (\$17,900/yr)	21	0	0	- INCLUDED IN UNIT 14 -	14 -	8,736
19			INCLUDED IN UNIT 8, IF REQUIRED				
			TOTALS				170,976

* TOTAL STAFF = TOTAL STAFF $\frac{\text{HRS}}{\text{YR}} \div \frac{\text{PERSON-HRS}}{\text{YR}} = 170,976 \div 2080 = 82.2$ (USE 82 OR 83 PERSONS)

** DEPENDENT ON GASIFICATION TECHNOLOGY USED. (NUMBER OF GASIFIERS & FEED SYSTEMS PER MODULE AND RELATIVE ATTENTION REQUIRED.)

THE BDM CORPORATION

OPERATING COST DATA

PROCESS: Texaco
 ITEM: Staffing Requirements Costs
 REFERENCE: TVA Design Criteria and Staffing Needs defined by
 BDM/Mittelhauser
 METHOD:

<u>JOB DESCRIPTION</u>	<u>COMPENSATION RATE</u>	<u>HRS/ YEAR</u>	<u>COST/ YEAR</u>	<u>FRINGES</u>	<u>TOTAL</u>
I. OPERATING LABOR					
MECHANICAL UNIT FOREMAN	\$21,600/YEAR	2,080	\$ 21,600	1.42	30,672
ELECTRICIAN	\$14.50/HR	2,080	\$ 30,160	0	30,160
COAL HAULING FOREMAN	\$14.00/HR	4,160	\$ 58,240	0	58,240
LABORER	\$ 8.50/HR	4,160	\$ 35,360	0	35,360
HEAD OPERATOR	\$13.00/HR	2,080	\$ 27,040	0	27,040
INSTRUMENT UNIT FOREMAN	\$21,600/YEAR	2,080	\$ 21,600	1.42	30,672
INSTRUMENT MECHANIC	\$14.50/HR	2,080	\$ 30,160	0	30,160
CLASS C OPERATOR	\$15,200/YR	2,912	\$ 21,280	1.42	30,218
CLASS A OPERATOR	\$17,900/YR	61,152	\$526,260	1.42	747,289
PLANT LABORER	\$13,100/YR	11,648	\$ 73,360	1.42	104,171
CLASS B OPERATOR	\$16,400/YR	20,384	\$160,720	1.42	228,222
UNIT OPERATOR	\$20,300/YR	26,208	\$255,780	1.42	363,208
SUBTOTAL OPERATING LABOR		141,024			\$1,715,412
II SUPERVISION					
PLANT OPERATING SUPERVISOR	\$34,500/YR	2,080	\$ 34,500	1.42	48,990
YARD OPERATIONS SUPERVISOR	\$24,000/YR	4,160	\$ 48,000	1.42	68,160
SHIFT ENGINEER	\$27,600/YR	23,712	\$314,640	1.42	446,789
SUBTOTAL SUPERVISION		29,952			\$563,939
TOTAL STAFF REQUIREMENTS		170,976			\$2,279,351

THE BDM CORPORATION

OPERATING REQUIREMENTS FOR EXPECTED OPERATIONS TEXACO PROCESS

	BASIS	UNITS
Raw Materials		
Coal	TPY @ 100% Operation	1,825,000 TPY
Raw Water (@ 2533 gpm design)	Gallons/Year @ 100% Operation	1.33 Gallons/Year x 10 ⁹
Catalyst and Chemical Makeup		
Makeup	@ 100% Operation	\$ 255,000/Year
Initial Charge of Catalysts and Chemicals		\$ 607,000
Utility Requirements		
Import Power (@ 49500 KW)	Kwh/Yr @ 100% Operation	433,620,000 Kw-Hr/Yr.
Operating Requirements		
Labor		
Supervisors	mh/Yr	29,952 mh/Yr
Operators	mh/Yr	141,024 mh/Yr
Supplies	Factored as 15% of operating labor costs	
Maintenance Requirements		
Labor	Factored as 1.6% of total depreciable direct investment	
Supplies	Factored as 2.4% of total depreciable direct investment	
General Plant Staff	Factored as 30% of operating labor and maintenance labor & supervision	
Administration and Plant Overhead	Factored as 5% of operations & maintenance less feedstock and chemicals	
Total Net MBG Yield = (@100%)	28.581 x 10 ⁹ Btu/Year HHV 98.335 x 10 ⁹ SCF/Year	

THE BDM CORPORATION

ANNUAL MODULE OPERATING COSTS FOR EXPECTED OPERATIONS TEXACO PROCESS MILLIONS OF JANUARY '80 DOLLARS AT 90 PERCENT OPERATING CAPACITY

ITEM DESCRIPTION	UNITS	NET REQUIREMENTS	ANNUAL REQUIREMENTS	COST PER UNIT	ANNUAL COST (x 10 ⁶)
FEEDSTOCK: (KENTUCKY #9 SEAM, DEEP MINE)*	MMBTU	1.098 x 10 ⁵ MMBTU/DAY	3.607 x 10 ⁷ MMBTU/YEAR	\$1.25/ MMBTU	\$45.087
CATALYST & CHEMICAL MAKE-UP					0.229
SUBTOTAL FEEDSTOCK & CATALYST & & CHEMICALS					45.316
ELECTRIC POWER	KWH	49,500 KW	390,258,000 KWH/YEAR	\$0.027/ KWH	10.537
WATER	10 ³ GALLONS	2,533 gpm	1.198 x 10 ⁹ gal/year	\$0.80/ KGAL	0.959
OPERATING LABOR		141,024 hrs/year	141,024 hrs/year	\$12.16	1.710
OPERATING SUPPLIES	(15% of Operating Labor)				.256
MAINTENANCE LABOR	(1.6% of 1/4 of Total Facility Investment)				5.664
MAINTENANCE SUPPLIES	(2.4% of 1/4 of Total Facility Investment)				8.496
SUPERVISION			29,952 hrs/year	\$18.23	.564
GENERAL PLANT STAFF	(30% of Operating Labor, Maintenance Labor and Supervision)				2.381
ADMINISTRATION AND GENERAL OVERHEAD	5% Factor of Subtotal of O&M Expenses (Less Feedstock and Catalysts)				1.545
PROPERTY TAXES AND INSURANCE					-0-
GROSS ANNUAL OPERATING & MAINTENANCE COSTS					32.112
BYPRODUCTS CREDITS					-0-
NET ANNUAL OPERATING & MAINTENANCE COSTS					32.112
TOTAL FEEDSTOCK, CATALYSTS & CHEMICALS AND O&M COSTS					\$77.428

* MEAN BTU VALUE OF FEEDSTOCK = 10,980 BTU/LB.
21.96 MMBTU/TON

THE BDM CORPORATION

- d. **Texaco Present Value of Costs, Product Prices, and Cash Flow**

THE BDM CORPORATION

PRESENT VALUE OF CAPITAL AND OPERATING AND MAINTENANCE COSTS

(PKACII)

MILLIONS OF DOLLARS

ITEM DESCRIPTION	GENERAL FACILITY	MODULE 1	MODULE 2	MODULE 3	MODULE 4	TOTAL FACILITY
OPERATING AND MAINTENANCE EXPENSES						
FEEDSTOCK	0.00	496.99	477.68	465.11	458.81	1901.54
CATALYST + CHEMICALS	0.00	2.53	2.43	2.34	2.34	9.68
SUBTOTAL	0.00	499.52	480.11	467.45	461.15	1911.22
ELECTRIC POWER	0.00	104.37	99.71	97.48	95.43	396.99
WATER	0.00	3.45	3.43	3.24	3.07	13.58
OPERATING LABOR	0.00	17.60	16.90	16.56	16.23	67.30
OPERATING SUPPLIES	0.00	2.64	2.54	2.48	2.43	10.09
MAINTENANCE LABOR	0.00	59.70	57.32	56.14	55.01	228.17
MAINTENANCE SUPPLIES	0.00	89.54	85.97	84.21	82.52	342.25
SUPERVISION	0.00	5.79	5.56	5.45	5.34	22.13
GENERAL PLANT	0.00	24.46	23.49	23.01	22.55	93.51
ADMIN. + GENERAL	0.00	15.69	15.07	14.76	14.47	59.99
PROPERTY TAXES + INS	0.00	0.00	0.00	0.00	0.00	0.00
BYPRODUCT REV	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL	0.00	323.63	309.99	303.35	297.06	1234.02
SUBTOTAL O&M COSTS	0.00	823.10	790.10	773.84	758.20	3145.25
CAPITAL COSTS						
DEPRECIABLE INVESTMENT COST	136.10	430.26	359.53	400.93	350.77	1677.23
NON-DEPRECIABLE INVESTMENT COST	1.24	12.00	11.54	11.18	11.12	47.12
SUBTOTAL CAPITAL COSTS	137.34	442.26	371.06	412.10	361.89	1724.35
TOTAL PRESENT VALUE OF CAPITAL AND OPERATING AND MAINTENANCE COSTS	137.34	1265.37	1161.16	1185.94	1120.10	4869.60
ANNUAL PRODUCT (MMBTU)		25722900.	25722900.	25722900.	25722900.	
PRODUCT PRICE (\$/MMBTU) (JANUARY 1980 DOLLARS)						\$ 5.00
PRODUCT PRICE (\$/MMBTU) (CURRENT DOLLARS)						\$ 13.38

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THE BDM CORPORATION

TEXACO PROCESS FISCAL YEAR CASH FLOW SUMMARY CONSTANT 1980 DOLLAR PRICE SCHEME

FISCAL YEAR	CAPITAL INVESTMENT	O&M	CAPITAL RECOVERY	TOTAL COSTS	REVENUE	CASH FLOW
1980	10.82	0.00	0.00	10.82	0.00	-10.82
1981	44.39	0.00	0.00	44.39	0.00	-44.39
1982	177.00	0.00	0.00	177.00	0.00	-177.00
1983	430.35	0.00	0.00	430.35	0.00	-430.35
1984	635.47	0.00	0.00	635.47	0.00	-635.47
1985	588.16	42.02	43.05	673.23	64.24	-608.99
1986	364.15	127.39	109.32	600.86	192.73	-408.13
1987	100.96	298.56	221.96	621.48	449.70	-171.78
1988	0.00	342.59	235.01	577.60	513.95	-63.65
1989	0.00	344.14	219.60	563.74	513.95	-49.79
1990	0.00	346.07	205.20	551.27	513.95	-37.32
1991	0.00	348.64	191.81	540.45	513.95	-26.50
1992	0.00	351.24	179.23	530.47	513.95	-16.52
1993	0.00	353.87	167.49	521.36	513.95	-7.41
1994	0.00	356.52	156.56	513.08	513.95	0.87
1995	0.00	359.21	146.32	505.53	513.95	8.42
1996	0.00	361.93	136.74	498.67	513.95	15.28
1997	0.00	362.60	127.80	490.40	513.95	23.55
1998	0.00	363.28	119.42	482.70	513.95	31.25
1999	0.00	363.97	111.61	475.58	513.95	38.37
2000	0.00	364.67	104.32	468.99	513.95	44.96
2001	0.00	365.38	97.51	462.89	513.95	51.06
2002	0.00	366.09	91.11	457.13	513.95	56.75
2003	0.00	366.82	85.16	451.98	513.95	61.97
2004	0.00	367.53	79.59	447.12	513.95	66.81
2005	0.00	322.25	63.26	385.51	449.70	64.19
2006	0.00	230.65	41.26	271.91	321.22	49.31
2007	0.00	46.22	7.61	53.83	64.24	10.41

ALL FIGURES IN MILLIONS OF FISCAL 1980 DOLLARS

THE BDM CORPORATION

3. Babcock and Wilcox MBG

THE BDM CORPORATION

a. Babcock and Wilcox System Costs

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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 1-COAL PREPARATION & FEEDING
UNIT OPERATION NUMBER: 11
SUBSYSTEM: INERT GAS COMPRESSOR
REFERENCE SOURCE FOR COSTING: MITTELHAUSER INHOUSE COST DATA
REFERENCE SUBSYSTEM COST: $\$.97 \times 10^6$ (MID 1978 DOLLARS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 2590 BRAKE HORSE POWER (BHP)
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. CENTRIFUGAL COMPRESSOR WITH CONDENSING STEAM TURBINE AND STARTUP MOTOR.
2. THE REMAINDER OF SYSTEM 1 IS ALREADY INCLUDED IN SYSTEM 2 - GASIFICATION.
3. REFERENCE SUBSYSTEM COST IS A TOTAL INSTALLED COST.

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = REFERENCE SUBSYSTEM COST x ESCALATION FACTOR

INPUTS:

REFERENCE SUBSYSTEM COST = $\$.97 \times 10^6$ (MID 1978 DOLLARS)
ESCALATION FACTOR = 1.14 (TO JANUARY 1980 DOLLARS)

RESULTS:

TOTAL SUBSYSTEM COST = \$1,105,800 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX

SYSTEM: 2-GASIFICATION (INCLUDES SYSTEMS 1, 2 & 3)

UNIT OPERATION NUMBER: 20

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: B&W COST ESTIMATE 10/31/79 (REFER TO FOLLOWING PAGES)

REFERENCE SUBSYSTEM COST: \$52,000,000 (2ND Q'79) EQUIPMENT COST ONLY

REFERENCE CAPACITY: 2 x 2500 TPD TRAINS

TVA CAPACITY: 3 x 2500 TPD TRAINS

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. STEAM SUPERHEATER AND INERT COMPRESSOR SUBSYSTEM COSTS MUST BE ADDED TO THIS SHEET TO GET TOTAL 1 + 2 + 3 SYSTEM COSTS. SEE SEPARATE SHEET FOR SUPERHEATER AND COMPRESSOR SUBSYSTEM COSTS.
2. NO SPARE CAPACITY IS INCLUDED IN B&W SYSTEM COST.

COMPUTATION METHOD:

EQUIPMENT COST = REFERENCE SUBSYSTEM COST x CAPACITY FACTOR x
ESCALATION FACTOR

INPUTS:

REFERENCE SUBSYSTEM COST: \$52,000,000 (1979 DOLLARS)
CAPACITY FACTOR: $3/2 = 1.5$
ESCALATION FACTOR: 1.047 (1979 TO 1980 DOLLARS)

RESULTS:

EQUIPMENT COST = \$81,666,000 (JANUARY '80 DOLLARS)

TO DERIVE AN INSTALLED COST FROM THIS EQUIPMENT COST IT IS NECESSARY TO USE INSTALLATION FACTORS CALCULATED ON A SYSTEM WHICH CONTAINS COAL PREP., GASIFICATION, AND COOLING. THIS WAS OBTAINED FROM EPRI 531. SEE THE ADDITIONAL PAGES FOLLOWING.

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 2-GASIFICATION
UNIT OPERATION NUMBER: 20
SUBSYSTEM: STEAM SUPERHEATER (FIRED HEATER)
REFERENCE SOURCE FOR COSTING: MITTLEHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: $\$3.5 \times 10^6$ INSTALLED COST (AUGUST 1978 DOLLARS) (WITH INDIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 306 MMBTU/HR
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. NOTE THAT REFERENCE PRICE IS 1978 INSTALLED COST.
2. THIS ITEM IS TO BE INCLUDED IN THE SYSTEM 2 COST.
3. ONE HEATER ONLY - NO SPARE CAPACITY.

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = INSTALLED EQUIPMENT REFERENCE COST \times ESCALATION FACTOR

INPUTS:

INSTALLED EQUIPMENT REFERENCE COST: \$3,500,000 (1978 DOLLARS)
ESCALATION FACTOR = 1.14 (1978 TO 1980 DOLLARS)

RESULTS:

TOTAL SUBSYSTEM COST = \$3,990,000 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

5,000 T/DAY TVA GASIFICATION SYSTEM

NO. PULVERIZING SUB-SYSTEM

4	Gravimetric Feeder
4	MPS Pulverizer(s)
4	Pulverizer Drive
4	Pulverizer Air Fan & Drive
4	Direct Fired Air Heater
4	Cyclone Separator & Seals
8	Bag Filterhouse, Seals, Etc.
4	Fenwall Safety System
	Controls for Pulverizing
	Flues, Piping, Valves, Dampers, Etc.

NO. P. C. TRANSPORT SUB-SYSTEM

2	Vent Filterhouse, Etc.
2	Inert Gas Receiver
2	Reservoir Tank
4	Lock Hoppers
2	Feed Tank
8	Load Cells
2	Cardox System
	Controls for Transporting
	Flues, Piping, Valves, Dampers, Etc.

NO. GASIFICATION SUB-SYSTEM

2	Gasifier Furnace
40	Coal & Char Burners
2	Steam Drum
2	Heat Recovery Boiler
12	Soot Blowers
6	Circ. Pumps & Drives
2	Slag Removal System
10	Slag System Pumps and Drives
2	Primary Char Cyclones
2	Secondary Char Cyclones
2	Char Reinjection System
2	Water Treatment System
	Flues, Piping, Valves, Dampers, Etc.
	Controls
	Steel

TOTAL COST SECOND QUARTER 1979 = \$50MM

(The above costs do not include erection.)

THE DM CORPORATION

5,000 T/DAY TVA GASIFICATION SYSTEM (CONTINUED)

NO. PARTICULATE REMOVAL SUB-SYSTEM

2	Venturi Scrubber
2	Dehumidification Tower
2	Dehumidification Tower Heat Exchanger
4	Venturi Pumps
4	Tower Pumps & Drives
	Flues, Piping, Valves, Dampers, Etc.

TOTAL COST SECOND QUARTER 1979 = \$2.0MM

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	BABCOCK & WILCOX
<u>SYSTEM:</u>	3-GAS COOLING
<u>UNIT OPERATION NUMBER:</u>	21
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	SEE SYSTEM 2 (2 INCLUDES SYSTEMS 1 & 3)
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	N/A

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX

SYSTEM: (1) COAL PREPARATION, (2) GASIFICATION,
AND (3) GAS COOLING

UNIT OPERATION NUMBER: N/A

SUBSYSTEM: INCLUDES SYSTEMS 1, 2 & 3

REFERENCE SOURCE FOR COSTING: EPRI AF-531 AND B&W COST ESTIMATE
10/31/79

REFERENCE SUBSYSTEM COST: EQUIPMENT COST = \$81,666,000 (JANUARY '80
DOLLARS) (REFER TO ENCLOSED PAGES)

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: EQUIPMENT COST IS TOTALED FROM PREVIOUS
PAGES

COMPUTATION METHOD:

DIRECT INSTALLATION COST = EQUIPMENT COST \times (INSTALLATION COST
FACTOR + 1)

TOTAL SUBSYSTEMS COST = DIRECT INSTALLATION COST \times (1 + INDIRECT COST
FACTOR)

INPUTS:

EQUIPMENT COST: \$81,666,000 (JANUARY '80 DOLLARS)
INSTALLATION COST FACTOR = 1.31 (FROM FOLLOWING PAGE)
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO) (REFER
TO SUMMARY OF INDIRECT CONSTRUCTION COST ASSUMPTIONS, FIGURE II-3)

RESULTS:

DIRECT INSTALLATION COST = \$188,648,460 (JANUARY '80 DOLLARS)
TOTAL SUBSYSTEMS COST = \$256,561,900 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX

SYSTEM: (1) COAL PREPARATION, (2) GASIFICATION,
AND (3) GAS COOLING

UNIT OPERATION NUMBER: N/A

SUBSYSTEM: INSTALLATION COST FACTORS

REFERENCE SOURCE FOR COSTING: EPRI AF-531, AUGUST 1977 P. 98

THE KOPPERS - TOTZEK ESTIMATE IN THIS REFERENCE INCLUDED A VENDOR ESTIMATE WITH DETAILED EQUIPMENT SPECIFICATIONS AND ALLOWANCES FOR SOME PIPING MATERIALS. FACTORS WERE THEN APPLIED TO THIS BASE TO ACCOUNT FOR OTHER MATERIALS AND LABOR REQUIRED FOR INSTALLATION. THE LIST BELOW REPRESENTS THOSE FACTORS NECESSARY FOR PROPER ADJUSTMENT OF THE B&W VENDOR QUOTE. THEY WERE PREPARED BY TVA.

REFERENCE SYSTEM COST*:

EQUIPMENT	=	\$22,050,000 (1974 \$)	<u>% of E</u>
PIPING, INSULATION, DUCTWORK, CHUTES, AND SUPPORTS	=	10,351,000	47.0%
SLURRY PIPING	=	275,000	1.2%
FOUNDATIONS & EXCAVATION	=	2,668,000	12.0%
STRUCTURAL	=	6,929,000	31.0%
ELECTRICAL	=	7,487,000	34.0%
INSTRUMENTS (ALREADY INCLUDED IN B&W ESTIMATE)	=	624,000	2.8%
PAINT & MISCELLANEOUS	=	468,000	2.1%
BUILDINGS (ACCOUNTED FOR ELSEWHERE)	=	211,000	1.0%
LAND	=	3 ACRES	
TOTAL INSTALLATION COST FACTOR			131.1%

* THESE COSTS INCLUDE MATERIALS AND LABOR

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BABCOCK & WILCOX PROCESS, SYSTEMS NO. 1, 2, AND 3,
COAL PREPARATION, FEED, GASIFICATION, AND GAS COOLING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. INERT GAS COMPRESSOR	\$1.106	\$1.106	\$1.106	\$1.106
SUBSYSTEM NO. STEAM SUPER HEATER	\$3.990	\$3.990	\$3.990	\$3.990
SUBSYSTEM NO. GASIFIER	\$256.562	\$256.562	\$256.562	\$256.562
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$261.658	\$261.658	\$261.658	\$261.658
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL: 15%	\$ 39.249	\$ 39.249	\$ 39.249	\$ 39.249
TOTAL SYSTEM CAPITAL INVESTMENT:	\$300.907	\$300.907	\$300.907	\$300.907

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 4-ACID GAS REMOVAL
UNIT OPERATION NUMBER: 22
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: EPRI AF-916 CASE 4
REFERENCE SYSTEM COST: \$54,227,000 (MID-1976 DOLLARS)
REFERENCE CAPACITY: 407,775 ACFH
TVA CAPACITY: 325,053 ACFH
RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

1. REFERENCE COST EQUALS 1/3 OF REFERENCE SYSTEM COST SINCE REFERENCE SYSTEM INCLUDES 3 TRAINS
2. NO SPARE CAPACITY INCLUDED. ONE TRAIN REQ'D FOR TVA.

COMPUTATION METHOD:

$$\frac{\text{TVA \$}}{\text{MODULE}} = \frac{\text{REF \$}}{3} \times \left(\frac{\text{TVA ACFH}}{\text{REF ACFH}} \right)^{0.6} \times \text{ESCALATION FACTOR}$$

INPUTS:

REFERENCE COST = \$54,227,000 (MID-1976 DOLLARS) (3 TRAINS)

ESTIMATED REFERENCE COST OF ONE TRAIN = \$18,075,666

CAPACITY FACTOR = $(325,053/407,775)^{0.6} = .87$

ESCALATION FACTOR = 1.30 (1976 TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$18,075,666 x .87 = \$15,725,829 (MID-76 DOLLARS)

TOTAL SYSTEM COST = \$20,443,578 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BABCOCK & WILCOX PROCESS, SYSTEM NO. 4, ACID GAS REMOVAL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 20.444	\$ 20.444	\$ 20.444	\$ 20.444
TOTAL PROCESS CONTINGENCY: 5%				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 1.022	\$ 1.022	\$ 1.022	\$ 1.022
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 21.466	\$ 21.466	\$ 21.466	\$ 21.466

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 5-SULFUR RECOVERY & TAIL GAS TREATMENT
UNIT OPERATION NUMBER: 36
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: DOE FE-1775-18, PLANT 2
REFERENCE SYSTEM COST: (6,032,000 MID '77\$) SULFUR PLANT
(3,000,000 MID '77\$) TAIL GAS TREATMENT
(9,032,000 MID '77\$) TOTAL REF COST
REFERENCE CAPACITY: 181.2 LTPD
TVA CAPACITY: 165 LTPD
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS:

1. PROCESS NOTE: NOMINAL OPERATING RATE FOR PLANT 2 IS 240 M/H FEED ALTHOUGH DESIGN RATE IS 527.5 M/H.
2. PROVIDE 2 (TWO) SULFUR PLANTS FOR MODULE 1; PROVIDE 1 PLANT EACH FOR MODULES 2, 3, & 4.

COMPUTATION METHOD:

$$\text{TOTAL SYSTEM COST} = \text{REFERENCE SYSTEM COST} \times \text{INDIRECT FACTOR} \times \left(\frac{\text{TVA CAP}}{\text{REF CAP}} \right)^{0.6} \times \text{NO. OF TRAINS} \times \text{ESCALATION FACTOR}$$

INPUTS:

REFERENCE SYSTEM COST = \$9,032,000 (MID-1977 DOLLARS)

ADJUSTMENT TO INCLUDE INDIRECT CONSTRUCTION ENGINEERING/HOME OFFICE COSTS = 1.10

$$\text{CAPACITY FACTOR} = \left(\frac{165}{181.2} \right)^{0.6} = .945$$

TRAINS (FOR MODULE 1) = 2

TRAINS (FOR MODULES 2, 3, 4) = 1

ESCALATION FACTOR = 1.22 (1977 TO 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA (CONTINUED)

RESULTS:

TOTAL SYSTEM COST = $\$9,935,200 \times .945 \times 2$ (TWO TRAINS FOR MODULE 1) =
\$18,777,528 (MID-'77 DOLLARS)

TOTAL SYSTEM COST FOR MODULE I IN JANUARY '80 DOLLARS = \$22,908,584
(JANUARY '80 DOLLARS)

TOTAL SYSTEM COST FOR MODULES II, III, AND IV = \$11,454,292

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BABCOCK & WILCOX PROCESS, SYSTEM NO. 5, SULFUR RECOVERY SYSTEM SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 22.908	\$ 11.454	\$ 11.454	\$ 11.454
TOTAL PROCESS CONTINGENCY: 15%				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 3.436	\$ 1.718	\$ 1.718	\$ 1.718
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 26.344	\$ 13.172	\$ 13.172	\$ 13.172

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX

SYSTEM: 6-AIR SEPARATION

UNIT OPERATION NUMBER: 80

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: MITTLEHAUSER AIR PLANT COST CURVES

REFERENCE SYSTEM COST: AIR PLANT COST = $\$34,955 \times 10^6$ (JANUARY '80 DOLLARS)

REFERENCE CAPACITY: DRIVERS COST = $\$2.87 \times 10^6$ (AUGUST '78 DOLLARS) (INSTALLED COST PER TRAIN)

TVA CAPACITY: $2 \times 1,890 = 3,780$ TPD (FOR TWO TRAINS)
@ 24.7 PSIA O_2

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. EACH TVA MODULE CONSISTS OF 2 OXYGEN PLANT TRAINS: TOTAL OXYGEN CAPACITY PER MODULE = 3,780 TPD.
2. NO SPARE CAPACITY INCLUDED.

INCLUDES PACKAGE AIR SEPARATION PLANT, AIR COMPRESSOR (CONDENSING TURBINE DRIVER), OXYGEN COMPRESSOR (CONDENSING TURBINE DRIVER), ELECTRIC MOTORS FOR STARTUP AND REQUIRED AUXILLARY EQUIPMENT.

COMPUTATION METHOD:

REFERENCE SYSTEM COST = AIR PLANT COST + DRIVERS COST \times ESCALATION FACTOR

INPUTS:

AIR PLANT COST = $\$34,955 \times 10^6$ (JANUARY '80 DOLLARS)

ESCALATION FACTOR = 1.14 (1978 TO 1980 DOLLARS)

DRIVERS COST = $\$2,871 \times 10^6$ (AUGUST '78 DOLLARS)

RESULTS:

REFERENCE SYSTEM COST = $\$38,228 \times 10^6$ (JANUARY '80 DOLLARS)

TOTAL SYSTEM COST = $\$76,455,880$ (JANUARY '80 DOLLARS)

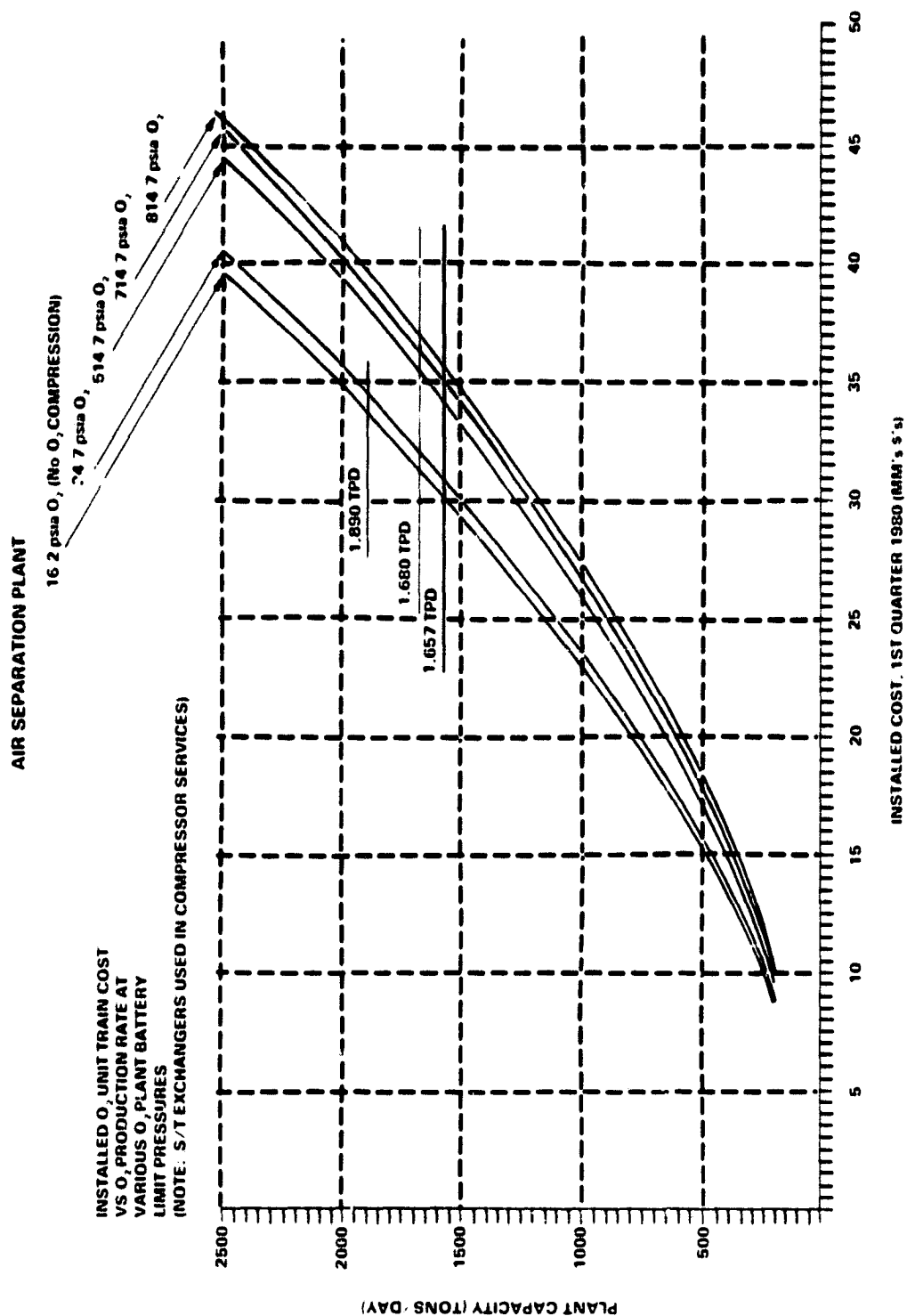


Figure III-1.1. Air Separation System Cost Curves

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BABCOCK & WILCOX PROCESS, SYSTEM NO. 6, AIR SEPARATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$76.456	\$76.456	\$76.456	\$76.456
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$76.456	\$76.456	\$76.456	\$76.456

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 7-COMPRESSION
UNIT OPERATION NUMBER: 23
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA
REFERENCE SYSTEM COST: $\$3.3 \times 10^6$ (AUGUST '78 DOLLARS)
(TOTAL COSTS - DIRECT AND INDIRECT)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 20,800 HP
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

- (1) COST OF CENTRIFUGAL COMPRESSOR, STEAM TURBINE DRIVER (NON-CONDENSING) AND AUXILIARIES AND START-UP ELECTRIC MOTOR.
- (2) COMPRESSION SYSTEM DID NOT APPEAR IN LEVEL 5.2.1 COSTS BECAUSE THE GASIFIER DESIGN PRESSURE WAS 1500 PSIG. DESIGN PRESSURE HAS BEEN REDUCED TO 225 PSIG.

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST \times ESCALATION FACTOR

INPUTS:

REFERENCE SYSTEM COST = $\$3.3 \times 10^6$ (AUGUST '78 DOLLARS)
ESCALATION FACTOR = 1.14 (1978 TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$3.762 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BABCOCK & WILCOX PROCESS, SYSTEM NO. 7, COMPRESSION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 3.762	\$ 3.762	\$ 3.762	\$ 3.762
TOTAL PROCESS CONTINGENCY: 5%				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$.188	\$.188	\$.188	\$.188
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 3.950	\$ 3.950	\$ 3.950	\$ 3.950

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 8-PROCESS SOLIDS TREATMENT
UNIT OPERATION NUMBER: 31
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: \$393,140 (JANUARY '80 DOLLARS) SEE BELOW
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

$$\text{TOTAL SYSTEM COST} = \text{TOTAL DIRECT COST} \times (1 + \text{INDIRECT COST FACTOR})$$

INPUTS:

DIRECT COST =

CLARIFIER A (MAIN)	98,600
CLARIFIER B (POLISHING)	37,540
LIME PONDS	75,000
CONVEYOR	162,000
CONTINGENCY	20,000
TOTAL DIRECT COST	\$393,140

(INCLUDES PUMPS, CHEMICAL FEED EQUIPMENT, AND INSTRUMENTS)
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED M/L RATIO)

RESULTS:

$$\begin{aligned}\text{TOTAL SYSTEM COST} &= .393 \times 1.36 \\ &= \$0.534 \text{ (JANUARY '80 DOLLARS)}\end{aligned}$$

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BABCOCK & WILCOX PROCESS, SYSTEM NO. 8, PROCESS SOLIDS TREATMENT SYSTEM CAPITAL INVESTMENT TABLE

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 0.534	\$ 0.534	\$ 0.534	\$ 0.534
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	-0-	-0-	-0-	-0-
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 0.534	\$ 0.534	\$ 0.534	\$ 0.534

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX

SYSTEM: 10-INSTRUMENTATION AND CONTROL

UNIT OPERATION NUMBER: N/A

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: VENDOR ESTIMATE FROM GENERAL ELECTRIC

REFERENCE SYSTEM COST: \$1.5 MILLION FOR A SYSTEM WITH CAPACITY SUFFICIENT FOR TVA NEEDS. IT IS BASED UPON A HONEYWELL 4500 SYSTEM.

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THE SYSTEM CONTAINS JUST THE NECESSARY MATERIAL FOR THE CENTRALIZED REMOTE FACILITY. IT CONTAINS SUFFICIENT CABLE TO TRANSMIT SIGNALS FROM THE PROCESS UNITS; DATA PROCESSING EQUIPMENT, SOFTWARE PACKAGES FOR THE ANALYSIS OF INCOMING DATA, AND DISPLAY PANELS FOR PRESENTATION OF DATA. THIS SYSTEM DOES NOT INCLUDE LOCAL CONTROLS FOR DIRECT OPERATION OF INDIVIDUAL SYSTEMS.

COMPUTATION METHOD:

TOTAL DIRECT COST = (1 + INSTALLATION FACTOR) x REFERENCE COST
TOTAL SYSTEM COST = (1 + INDIRECT COST FACTOR) x TOTAL DIRECT COST

INPUTS:

FIELD INSTALLATION FACTOR = 1.10 (ASSUMED)

TOTAL DIRECT COSTS = $\$3.15 \times 10^6$ (JANUARY '80 DOLLARS)

INDIRECT COST FACTOR = 0.289 (ASSUMED 90/10 M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = \$4.06035

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BABCOCK & WILCOX PROCESS, SYSTEM NO. 10, INSTRUMENTATION & CONTROL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 4.06	\$ 4.06	\$ 4.06	\$ 4.06
TOTAL PROCESS CONTINGENCY: 15%				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 0.609	\$ 0.609	\$ 0.609	\$ 0.609
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 4.669	\$ 4.669	\$ 4.669	\$ 4.669

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX

SYSTEM: 11-COAL HANDLING

UNIT OPERATION NUMBER: 10

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: RESOURCE ENGINEERING, INC. ESTIMATE BASED ON IN-HOUSE COST DATA. SEE DETAILED EQUIPMENT LISTING WHICH FOLLOWS.

REFERENCE SYSTEM COST: $\$48.1 \times 10^6$ (JANUARY '80 DOLLARS) (TOTAL DIRECT COST)

REFERENCE CAPACITY: 20,000 TPD

TVA CAPACITY: 20,000 TPD

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THIS SYSTEM IS SIZED TO SERVE THE NEEDS OF ALL FOUR (4) MODULES TO BE BUILT ON THE TVA FACILITY.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COST (E+M+L) = $\$48.1 \times 10^6$ (JANUARY '80 DOLLARS)

INDIRECT COST FACTOR = .335 (80/20 ASSUMED M/L RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SYSTEM COST = $\$64.2135 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM 11

COAL HANDLING

(EQUIPMENT FACTORED COSTS)

<u>DESCRIPTION</u>	<u>JAN '80 \$ x (10⁶)</u>
1. Continuous barge unloader, elevator type, 3,000-3,500 TPH, including dock, moorings, surge bin, conveyors	\$ 10.0
2. Open coal storage piles, 1.8 x 10 ⁶ tons Double windows 100' high x (2 x 240') wide x 2,800' Costs for site preparation, stockpiling conveyors, stacker/reclaiming equipment, mobile equipment	30.0
3. Rotary brakers, three (2N, 1S), 1,000 TPH each 50 hp each, 12' x 22' each	1.0
4. Concrete silos, four, 11,750 tons each, 67' x 150' each	6.0
5. Truck dump hopper, 2,000 tons	0.2
6. Conveyors not included above	0.3
a. Truck station to crusher, 500 TPH 36" x 500 ft., 0 elevation, 42G fpm, 32 hp	
b. Crusher to silos, 2,160 TPH 60" x 700 ft., 150 ft. elevation, 470 hp, 600 fpm	<u>0.6</u>
TOTAL DIRECT COSTS (E+M+L) =	\$ 48.1

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
BABCOCK & WILCOX PROCESS, SYSTEM NO. 11,

COAL HANDLING

SYSTEM CAPITAL INVESTMENT TABLE

GENERAL FACILITIES

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBTOTAL: _____

\$ 64.214

TOTAL PROCESS CONTINGENCY:

SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBTOTAL: _____

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 64.214

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX

SYSTEM: 12-SOLIDS WASTE RECYCLING/DISPOSAL

UNIT OPERATION NUMBER: 81

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATE (FROM IN-HOUSE COST DATA BASE)

REFERENCE SYSTEM COST: $\$16.1 \times 10^6$ (JANUARY '80 DOLLARS) (TOTAL DIRECT COSTS) (SEE BELOW)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 61,000 #/HR SOLIDS (DRY), 2319 GAL/HR H₂O W/SOLIDS

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. SYSTEM IS ESSENTIALLY AN EXCAVATED 20 YEARS AREA FOR SOLID DISPOSAL. INCLUDES EXCAVATION AND CONSTRUCT OF CLAY LINED DISPOSAL AREA. RUN OFF HOLDING POND.
2. INSTALLED COST OF SOLIDS DISPOSAL AREA = $\$10 \times 10^6$
INSTALLED COST OF RUN OFF COLLECTION BASIN = $\frac{6.1 \times 10^6}{\$16.1 \times 10^6}$
(BOTH ARE LINED W/CLAY LINER)
3. LAND COSTS WERE NOT INCLUDED

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COST = $\$16.1 \times 10^6$ (JANUARY '80 DOLLARS)

INDIRECT COST FACTOR = 0.335 (80/20 ASSUMED M/L RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SYSTEM COST = $\$21.494 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BABCOCK & WILCOX PROCESS, SYSTEM NO. 12,

SOLID WASTE RECYCLING/DISPOSAL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. LINED DISPOSAL AREA	\$ 13.350	\$ 13.350	\$ 13.350	\$ 13.350
SUBSYSTEM NO. RUNOFF COLLECTION	\$ 8.144	\$ 8.144	\$ 8.144	\$ 8.144
<u>SUBTOTAL:</u>	\$ 21.494	\$ 21.494	\$ 21.494	\$ 21.494

TOTAL PROCESS CONTINGENCY:

SUBSYSTEM NO. _____	-0-	-0-	-0-
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
<u>SUBTOTAL:</u>	-0-	-0-	-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 21.494	\$ 21.494	\$ 21.494	\$ 21.494
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THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	BABCOCK & WILCOX
<u>SYSTEM:</u>	13-BYPRODUCTS PROCESSING
<u>UNIT OPERATION NUMBER:</u>	83-SULFUR STORAGE & LOADING
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	MITTELHAUSER (IN-HOUSE COST DATA BASE)
<u>REFERENCE SYSTEM COST:</u>	$\$1 \times 10^6$ (JANUARY '80 DOLLARS)
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	

TOTAL SYSTEM COST = $\$1 \times 10^6$ FOR EACH MODULE OR \$4 MILLION FOR ENTIRE FACILITY

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BABCOCK & WILCOX PROCESS, SYSTEM NO. 13,
BYPRODUCTS PROCESSING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
UNIT OPERATIONS 83-SULFUR				
STORAGE HANDLING	\$1	\$1	\$1	\$1
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$1	\$1	\$1	\$1
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$1	\$1	\$1	\$1

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 14-PLANT POWER
UNIT OPERATION NUMBER: 87
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA, p. 363
REFERENCE SYSTEM COST: \$102.62 (1970 DOLLARS/KILOWATT) (FACTOR FOR ELECTRICAL DISTRIBUTION FIELD INSTALLATION COSTS IN NORMAL RANGE)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 5800 KW
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS PROCESS DOES NOT INCLUDE ANY POWER GENERATING CAPACITY. SYSTEM COSTS REPRESENT ONLY POWER DISTRIBUTION NEEDS.

COMPUTATION METHOD:

SYSTEM COST = KILOWATT REQUIREMENT x TOTAL DIRECT COST FACTOR x
(1 + INDIRECT COST FACTOR) x ESCALATION FACTOR FOR JANUARY '80
DOLLARS

INPUTS:

KILOWATT REQUIREMENT = 5800 KW
TOTAL DIRECT COST FACTOR = \$102.62 (1970 DOLLARS/PER KILOWATT)
INDIRECT COST FACTOR = 0.469 (BASED UPON 0.72 L/M RATIO)
ESCALATION FACTOR = 1.988 (FROM 1970 TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$1.738 x 10⁶ JANUARY '80 DOLLARS

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BABCOCK & WILCOX PROCESS, SYSTEM NO. 14, PLANT POWER

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 1.738	\$ 1.738	\$ 1.738	\$ 1.738
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 1.738	\$ 1.738	\$ 1.738	\$ 1.738

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 15-STEAM GENERATION/DISTRIBUTION
UNIT OPERATION NUMBER: 84
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA
PROCESS PLANT ESTIMATED EVALUATION AND
CONTROL, p. 365
REFERENCE SYSTEM COST: TOTAL DIRECT COST FACTOR = 1.68 (1970
DOLLARS PER LBS/HR)
REFERENCE CAPACITY: N/A
TVA CAPACITY: STEAM REQUIREMENT = 923,300 LBS/HR
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:

SYSTEM DESIGN DOES NOT REQUIRE ANY INDEPENDENT STEAM GENERATION
BOILERS. SYSTEM COSTS REPRESENT DISTRIBUTION REQUIREMENTS INCLUDING
PIPING, TRAPS, AND SUPERHEATERS.

COMPUTATION METHOD:

TOTAL SYSTEM COST = STEAM REQUIREMENT x TOTAL DIRECT COST FACTOR x
(1 + INDIRECT COST FACTOR) x ESCALATION FACTOR

INPUTS:

STEAM REQUIREMENT = 923,300 LBS/HR.
TOTAL DIRECT COST FACTOR = 1.68 (1970 DOLLARS PER LBS/HR.)
INDIRECT COST FACTOR = 0.488
ESCALATION FACTOR = 1.988 (FROM 1970 TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$4.589 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BABCOCK & WILCOX PROCESS, SYSTEM NO. 15, STEAM GENERATION & DISTRIBUTION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____	\$ 4.589	\$ 4.589	\$ 4.589	\$ 4.589
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>				
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>				
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 4.589	\$ 4.589	\$ 4.589	\$ 4.589

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 16-WATER SUPPLY
UNIT OPERATION NUMBER: 85
SUBSYSTEM: DEMINERALIZATION
REFERENCE SOURCE FOR COSTING: MITTELMEYER ESTIMATED DESIGN EQUIPMENT COSTS (SEE BELOW)
REFERENCE SYSTEM COST: \$2,312,000 (JANUARY '80 DOLLARS) (SEE BELOW)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD: N/A

$$\text{TOTAL SYSTEM COST} = (\text{INSTALLED COST} - \text{CONTINGENCY}_1) \times (1 + \text{INDIRECT COST FACTOR})$$

$$\text{CONTINGENCY}_2 = \text{TOTAL SYSTEM COST} \times \text{CONTINGENCY FACTOR}_2$$

INPUTS:

REFERENCE SYSTEM COST	
PRESSURE FILTERS	\$ 54,000
DEMINERALIZERS	2,130,000
CHEM. STORAGE TANKS	53,000
CONTINGENCY ₁	<u>75,000</u>

INCLUDE PUMPS, CHEM. FEED, INSTRUMENTS \$2,312,000

INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED M/L RATIO FOR MIXED PROCESSES)

$$\text{CONTINGENCY FACTOR}_2 = 0.05$$

RESULTS:

TOTAL SYSTEM COST = \$3,042.320 (JANUARY '80 DOLLARS)

$$\text{CONTINGENCY}_2 = \$0.152 \times 10^6$$

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 16-WATER SUPPLY
UNIT OPERATION NUMBER: 85
SUBSYSTEM: RAW WATER CLARIFICATION
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: $\$1.4 \times 10^6$ (JANUARY '80 DOLLARS)
(FACTORED FROM K-T COST ESTIMATES)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:

REFERENCE SYSTEM COST INCLUDES FIRE POND, CLARIFIER, RECARBONATOR,
CHEMICAL FEED EQUIPMENT, PUMPS AND INSTRUMENTS)

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

REFERENCE SYSTEM COST = $\$1.4 \times 10^6$
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = $\$1,904 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BABCOCK & WILCOX PROCESS, SYSTEM NO. 16,
WATER SUPPLY

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM-DEMINEALIZER	\$ 3.042	\$ 3.042	\$ 3.042	\$ 3.042
SUBSYSTEM-CLARIFICATION	\$ 1.904	\$ 1.904	\$ 1.904	\$ 1.904
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 4.946	\$ 4.946	\$ 4.946	\$ 4.946
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM-DEMINEALIZER (5%)	\$ 0.152	\$ 0.152	\$ 0.152	\$ 0.152
SUBSYSTEM-CLARIFICATION (0%)				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 0.152	\$ 0.152	\$ 0.152	\$ 0.152
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 5.098	\$ 5.098	\$ 5.098	\$ 5.098

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 17-COOLING WATER SYSTEM
UNIT OPERATION NUMBER: 39
SUBSYSTEM: GASIFIER COOLING TOWER
REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATE
REFERENCE SUBSYSTEM COST: $\$0.460 \times 10^6$ (DIRECT COST ONLY QTR '80)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 5917 GPM CIRC. RATE
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:

DIRECT COST, (INCL. PUMPS, CONCRETE, ETC) = \$460,000 (1ST QTR 80)

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = REFERENCE SYSTEM COST \times (1 + INDIRECT
COST FACTOR)

INPUTS:

REFERENCE SYSTEM COST = \$460,000 (JANUARY '80 DOLLARS)
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED M/L RATIO)

RESULTS:

TOTAL SUBSYSTEM COST = \$625,600 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 17-COOLING WATER SYSTEM
UNIT OPERATION NUMBER: 39
SUBSYSTEM: UTILITY COOLING TOWER
REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATE
REFERENCE SUBSYSTEM COST: 4.47×10^6 (JANUARY 1980 DOLLARS)
(DIRECT COST)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 76,500 GPM CIRC. RATE
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:

DIRECT COST, (INCL. PUMPS, CONCRETE, ETC) = \$4,470,000 (1ST QTR 80)

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = REFERENCE SUBSYSTEM COST \times (1 + INDIRECT
COST FACTOR)

INPUTS:

REFERENCE SUBSYSTEM COST = 4.470×10^6 (JANUARY 1980 DOLLARS)
INDIRECT COST FACTOR = 0.36 (ASSUMED "NORMAL" M/L RATIO FOR MIXED
PROCESSES)

RESULTS:

TOTAL SUBSYSTEM COST = 6.079×10^6 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 17-COOLING WATER SYSTEM
UNIT OPERATION NUMBER: 39
SUBSYSTEM: EVAPORATOR
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SUBSYSTEM COST: $\$.6 \times 10^6$ (DIRECT COST ONLY JANUARY 1980 DOLLARS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = REFERENCE SUBSYSTEM COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

REFERENCE SUBSYSTEM COST = \$600,000 (JANUARY 1980 DOLLARS)
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED M/L RATIO FOR MIXED PROCESSES)

RESULTS:

TOTAL SUBSYSTEM COST = \$816,000 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BABCOCK & WILCOX PROCESS, SYSTEM NO. 17, COOLING WATER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. GASIFIER COOLING TOWER	\$ 0.626	\$ 0.626	\$ 0.626	\$ 0.626
SUBSYSTEM NO. UTILITIES COOLING TOWER	\$ 6.079	\$ 6.079	\$ 6.079	\$ 6.079
SUBSYSTEM NO. EVAPORATOR	\$ 0.816	\$ 0.816	\$ 0.816	\$ 0.816
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 7.521	\$ 7.521	\$ 7.521	\$ 7.521
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	-0-	-0-	-0-	-0-
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 7.521	\$ 7.521	\$ 7.521	\$ 7.521

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX
SYSTEM: 18-WASTE WATER TREATMENT
UNIT OPERATION NUMBER: 33
SUBSYSTEM: PROCESS CONDENSATE TREATMENT
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: \$108,000 (DIRECT COST ONLY JANUARY 1980 DOLLARS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:

1. INCLUDES CLARIFIER, PUMPS, CHEMICAL FEED EQUIPMENT, AND INSTRUMENTS

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

REFERENCE SYSTEM COST = $\$.108 \times 10^6$ (JANUARY 1980 DOLLARS)
INDIRECT COST FACTOR = 0.37 (75/25 ASSUMED M/L RATIO FOR CHEMICAL PROCESS SYSTEMS)

RESULTS:

TOTAL SYSTEM COST = \$148,000 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BABCOCK & WILCOX PROCESS, SYSTEM NO. 18,
WASTE WATER TREATMENT

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
UNIT OPERATION PROCESS CONDENSATE TREATMENT-33	\$ 0.148	\$ 0.148	\$ 0.148	\$ 0.148
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____	\$ 0.148	\$ 0.148	\$ 0.148	\$ 0.148
<u>SUBTOTAL:</u>				
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____	-0-	-0-	-0-	-0-
<u>SUBTOTAL:</u>				
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 0.148	\$ 0.148	\$ 0.148	\$ 0.148

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BABCOCK & WILCOX

SYSTEM: 19-BUILDING AND SUPPORT FACILITIES

UNIT OPERATION NUMBER: 88

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: EVALUATION OF INTERMEDIATE-BTU COAL GASIFICATION SYSTEMS FOR RETROFITTING POWER PLANTS, EPRI AF-531, AUGUST 1977

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

INVESTMENT FOR SERVICE FACILITIES SUCH AS MAINTENANCE SHOPS, STORES, COMMUNICATIONS, SECURITY, AND OFFICES IS ESTIMATED AT 4.9 PERCENT OF DIRECT INVESTMENT. THIS FACTOR WAS DERIVED BY TVA BASED ON ITS CONSTRUCTION EXPERIENCE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT SYSTEM INVESTMENT \times (.049) WHERE:

1. TOTAL DIRECT SYSTEM INVESTMENTS = TOTAL SYSTEM CAPITAL INVESTMENTS
- INDIRECT COSTS
2. = TSCI-TDSI \times INDIRECT COST FACTOR
3. = $\left(\frac{1}{1 + \text{INDIRECT COST FACTOR}} \right) \times \text{TSCI}$

INPUTS:

INDIRECT COST FACTOR = 0.36 (ASSUMED "NORMAL" M/L RATIO)
TOTAL SYSTEM CAPITAL INVESTMENT (LESS BUILDINGS & SUPPORT) =
 $\$1928.354 \times 10^6$

RESULTS:

TOTAL DIRECT SYSTEM INVESTMENTS = $\$1417.91 \times 10^6$

TOTAL SYSTEM COST = $\$69.477 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BABCOCK & WILCOX PROCESS, SYSTEM NO. 19,
BUILDING & SUPPORT FACILITIES

SYSTEM CAPITAL INVESTMENT TABLE

GENERAL FACILITIES

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBTOTAL: _____

\$ 69.477

TOTAL PROCESS CONTINGENCY:

SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBSYSTEM NO. _____
SUBTOTAL: _____

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 69.477

THE BDM CORPORATION

- b. Babcock and Wilcox "Instant Plant" Capital Costs

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THE BDM CORPORATION

FACILITY INVESTMENT AGGREGATION TABLE
BABCOCK AND WILCOX PROCESS
MILLIONS OF 1980 DOLLARS

ITEM DESCRIPTION	SYSTEM NO.	MODULE 1	MODULE 2	MODULE 3	MODULE 4	GENERAL FACILITIES	TOTAL
SYSTEM CAPITAL INVESTMENT							
COAL PREPARATION & FEEDING	1	300.907	300.907	300.907	300.907		1203.628
GASIFICATION	2						
INITIAL GAS CLEANUP & COOLING	3						
ACID GAS REMOVAL	4	21.466	21.466	21.466	21.466		85.864
SULFUR RECOVERY & TAILGAS TREATMENT	5	26.344	13.172	13.172	13.172		65.860
AIR SEPARATION	6	76.456	76.456	76.456	76.456		305.824
COMPRESSION	7	3.950	3.950	3.950	3.950		15.800
PROCESS SOLIDS TREATMENT(DEWATERING)	8	.534	.534	.534	.534		2.136
INCINERATION	9	-0-	-0-	-0-	-0-		-0-
INSTRUMENTATION & CONTROL	10	4.669	4.669	4.669	4.669		18.676
COAL HANDLING	11					64.214	64.214
SOLIDS WASTE RECYCLING/DISPOSAL	12	21.494	21.494	21.494	21.494		85.976
RYPRODUCTS PROCESSING	13	1.00	1.00	1.00	1.00		4.00
PLANT POWER SYSTEM	14	1.738	1.738	1.738	1.738		6.952
STEAM GENERATION/DISTRIBUTION	15	4.589	4.589	4.589	4.589		18.356
WATER SUPPLY	16	5.098	5.098	5.098	5.098		20.392
COOLING WATER SYSTEM	17	7.521	7.521	7.521	7.521		30.084
WASTE WATER TREATMENT	18	0.148	0.148	0.148	0.148		0.592
GENERAL FACILITIES (BLDG & SUPPORT)	19					69.477	69.477
SUBTOTAL (LESS BLDG & SUPPORT)							
(1) TOTAL SYSTEM CAPITAL INVESTMENT*		475.914	462.742	462.742	462.742	133.691	1928.354
(2) PROJECT CONTINGENCY 15 %		71.387	69.411	69.411	69.411	20.053	1997.831
[15% OF (1)]							299.637
(3) CONTRACTOR'S FEE 4 %		21.892	21.286	21.286	21.286	6.150	91.900
[4% OF (1) + (2)]							
(4) OWNER'S COSTS 2 %		11.384	11.069	11.069	11.069	3.198	47.789
[2% OF (1)+(2)+(3)]							
TOTAL FACILITY INVESTMENT		580.577	564.508	564.508	564.508	163.092	2437.193
[(1)+(2)+(3)+(4)]							
* INCLUDES PROCESS CONTINGENCIES WHICH TOTAL:							
TOTAL SYSTEM CAPITAL INVESTMENT LESS CONTINGENCY		44.656	42.938	42.938	42.938	-0-	173.47
		431.258	419.804	419.804	419.804	133.691	1824.361

THE BDM CORPORATION

OTHER CAPITALIZED COSTS AND WORKING CAPITAL BABCOCK AND WILCOX PROCESS MILLIONS OF 1980 DOLLARS

ITEM DESCRIPTION	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>	<u>GENERAL FACILITIES</u>	<u>TOTAL</u>
A. <u>OTHER CAPITALIZED COSTS</u>						
PAID-UP ROYALTIES	2.903	2.822	2.822	2.822	.815	12.184
0.5 % OF TFI	73.145	73.145	73.145	73.145	-0-	292.580
START-UP AND TESTING						
ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION	125.620	122.293	122.293	122.293	35.609	528.108
SUBTOTAL OF OTHER CAPITALIZED COSTS	<u>201.668</u>	<u>198.260</u>	<u>198.260</u>	<u>198.260</u>	<u>36.424</u>	<u>832.872</u>
B. <u>WORKING CAPITAL</u>						
INITIAL CHARGE OF CATALYSTS AND CHEMICALS	.608	.608	.608	.608	-0-	2.432
MATERIALS INVENTORIES	4.139	4.139	4.139	4.139	-0-	16.556
SPARE PARTS INVENTORIES	2.623	2.551	2.551	2.551	0.737	11.013
MINIMUM CASH BALANCE	10.927	10.927	10.927	10.927	-0-	43.708
SUBTOTAL WORKING CAPITAL	<u>18.297</u>	<u>18.225</u>	<u>18.225</u>	<u>18.225</u>	<u>0.737</u>	<u>73.709</u>

THE BDM CORPORATION

LAND REQUIREMENTS

BABCOCK AND WILCOX PROCESS

SYSTEM #	LAND UNIT	2	W	AREA FT ²	AREA PER UNIT	\$/ACRE OR \$/FT ²	UNITS PER SYSTEM	TOTAL AREA PER SYSTEM, ACRES	TOTAL COST
SUBTOTAL LAND REQUIREMENT						\$3000		300	\$ 900,000
LAND SURVEY AND FEES*									\$ 4,000
FIRE CONTROL*									\$ 260,000
ALLOWANCE FOR INTERCONNECTIONS, SITE PREPARATION, MISCELLANEOUS*						\$8100		300	\$2,430,000
SUBTOTAL DEPRECIABLE LAND RELATED EXPENSES TOTAL									\$2,694,000 \$3,594,000

* COSTS OBTAINED FROM MITTELHAUSER TO ESTIMATE TOTAL CAPITAL REQUIREMENT FOR PROCESSING FACILITIES

THE BDM CORPORATION

TOTAL CAPITAL REQUIREMENTS BABCOCK AND WILCOX PROCESS MILLIONS OF 1980 DOLLARS						
ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4	GENERAL FACILITIES	TOTAL
TOTAL FACILITY INVESTMENT	580.577	564.508	564.508	564.508	163.092	2,437.193
OTHER CAPITALIZED COSTS	201.668	198.260	198.260	198.260	198.260	832.872
LAND RELATED COSTS	-0-	-0-	-0-	-0-	2.694	2.694
SUBTOTAL DEPRECIABLE INVESTMENT	<u>782.245</u>	<u>762.768</u>	<u>762.768</u>	<u>762.768</u>	<u>202.210</u>	<u>3,272.759</u>
WORKING CAPITAL	18.297	18.225	18.225	18.225	.737	73.709
LAND	-0-	-0-	-0-	-0-	.900	.900
SUBTOTAL NON-DEPRECIABLE INVESTMENT	<u>18.297</u>	<u>18.225</u>	<u>18.225</u>	<u>18.225</u>	<u>1.637</u>	<u>74.609</u>
TOTAL CAPITAL REQUIREMENTS	<u>800.542</u>	<u>780.993</u>	<u>780.993</u>	<u>780.993</u>	<u>203.847</u>	<u>3,347.368</u>

THE BDM CORPORATION

c. **Babcock and Wilcox Operations and Maintenance Costs**

THE BDM CORPORATION

OPERATING REQUIREMENTS FOR EXPECTED OPERATIONS

BABCOCK AND WILCOX PROCESS

	BASIS	UNITS
Raw Materials Coal	TPY @ 100% Operation	1,825,000 TPY
Catalyst and Chemical Makeup	100% Operation	262,200 \$/Yr
Initial Charge		\$608,000
Utility Requirements Import Power Water	Kwh/Yr @ 100% Operation	50,808,000 Kw-Hr/Yr 2,778 GPM
Operating Requirements Labor Supervisors Operators Supplies	mh/Yr mh/Yr Factored as 15% of operating labor costs	29,952 141,024
Maintenance Requirements Labor Supplies	Factored as 1.6% of average modular total system cost Factored as 2.4% of average modular total system cost	
General Plant Staff	Factored as 30% of operating labor and maintenance labor & supervision	
Administration and Plant Overhead	Factored as 5% of operations & maintenance less feedstock and chemicals	
Module Net MBG Yield	@ 100% Operation	27,648,093 MMBTU/Year

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THE BDM CORPORATION

BABCOCK AND WILCOX STAFFING REQUIREMENTS* MODULE OPERATIONS MANPOWER

SYSTEM NO.	OPERATORS PER SHIFT	SHIFTS PER WEEK	UTILITY		SHIFTS PER WEEK	UNIT		SHIFTS PER WEEK	TOTAL HOURS PER YEAR	
			MEN PER SHIFT	PER SHIFT		SUPVS PER SHIFT	INCLUDED IN UNIT			
1	1 (\$21,600/yr)	5	1 (\$14.50/hr)		5	1 (\$34,500/yr)		5	6,240	
2	2 (\$14.00/hr)	5	1 (\$8.50/hr)		5	1 (\$24,000/yr)		5	8,320	
3	1 (\$13.00/hr)	5	1 (\$8.50/hr)		5	1 (\$24,000/yr)		5	6,240	
4	1 (\$21,600/hr)	5	1 (\$14.50/hr)		5	- INCLUDED IN UNIT 1 -		1 -	4,160	
5			INCLUDED IN UNIT 8							
6	0	0	1 (\$15,200/yr)		7	- INCLUDED IN UNIT 14 -			2,912	
7	1 (\$17,900/yr)	21	1 (\$13,100/yr)		7	1 (\$27,600/yr)		21	20,384	
8	1 (\$17,900/yr)	21	1 (\$13,100/yr)		21	1 (\$27,600/yr)		5	19,552	
9			INCLUDED IN UNIT 7							
10	2 (\$17,900/yr)	21			INCLUDED IN UNIT 7				17,472	
11	(-)**(\$17,900/yr)	21	(1)**(\$16,400/yr)		21	-INCLUDED IN UNIT 12-			8,736	
12	(2)**(\$20,300/yr)	21	(1)**(\$16,400/yr)		21	1 (\$27,600/yr)			34,944	
13			INCLUDED IN UNIT 12							
14	1 (\$20,300/yr)	21	1 (\$16,400/yr)		7	1 (\$27,600/yr)			13,728	
15	1 (\$17,900/yr)	21			INCLUDED IN UNIT 3				8,736	
16			INCLUDED IN UNIT 12							
17	1 (\$17,900/yr)	21	0		0	1 (\$27,600/yr)			10,816	
18	1 (\$17,900/yr)	21	0		0	- INCLUDED IN UNIT 14 -			8,736	
19			INCLUDED IN UNIT 8, IF REQUIRED							
						TOTALS			170,976	

* TOTAL STAFF = TOTAL STAFF $\frac{\text{HRS}}{\text{YR}} \div \frac{\text{PERSON-HRS}}{\text{YR}} = 170,976 \div 2080 = 82.2$ (USE 82 OR 83 PERSONS)

** DEPENDENT ON GASIFICATION TECHNOLOGY USED. (NUMBER OF GASIFIERS & FEED SYSTEMS PER MODULE AND RELATIVE ATTENTION REQUIRED.)

THE BDM CORPORATION

OPERATING COST DATA

PROCESS: Babcock and Wilcox
 ITEM: Staffing Requirements Costs
 REFERENCE: TVA Design Criteria and Staffing Needs defined by
 BDM/Mittelhauser
 METHOD:

<u>JOB DESCRIPTION</u>	<u>COMPENSATION RATE</u>	<u>HRS/ YEAR</u>	<u>COST/ YEAR</u>	<u>FRINGES</u>	<u>TOTAL</u>
I. <u>OPERATING LABOR</u>					
<u>MECHANICAL UNIT</u>					
FOREMAN	\$21,600/YEAR	2,080	\$ 21,600	1.42	30,672
ELECTRICIAN	\$14.50/HR	2,080	\$ 30,160	0	30,160
<u>COAL HAULING</u>					
FOREMAN	\$14.00/HR	4,160	\$ 58,240	0	58,240
LABORER	\$ 8.50/HR	4,160	\$ 35,360	0	35,360
HEAD OPERATOR	\$13.00/HR	2,080	\$ 27,040	0	27,040
<u>INSTRUMENT UNIT</u>					
FOREMAN	\$21,600/YEAR	2,080	\$ 21,600	1.42	30,672
INSTRUMENT MECHANIC	\$14.50/HR	2,080	\$ 30,160	0	30,160
CLASS C OPERATOR	\$15,200/YR	2,912	\$ 21,280	1.42	30,218
CLASS A OPERATOR	\$17,900/YR	61,152	\$526,260	1.42	747,289
PLANT LABORER	\$13,100/YR	11,648	\$ 73,360	1.42	104,171
CLASS B OPERATOR	\$16,400/YR	20,384	\$160,720	1.42	228,222
UNIT OPERATOR	\$20,300/YR	26,208	\$255,780	1.42	363,208
SUBTOTAL OPERATING LABOR		141,024			\$1,715,412
II <u>SUPERVISION</u>					
<u>PLANT OPERATING</u>					
SUPERVISOR	\$34,500/YR	2,080	\$ 34,500	1.42	48,990
<u>YARD OPERATIONS</u>					
SUPERVISOR	\$24,000/YR	4,160	\$ 48,000	1.42	68,160
SHIFT ENGINEER	\$27,600/YR	23,712	\$314,640	1.42	446,789
SUBTOTAL SUPERVISION		29,952			\$563,939
TOTAL STAFF REQUIREMENTS		170,976			\$2,279,351

THE BDM CORPORATION

ANNUAL MODULE OPERATING COSTS FOR EXPECTED OPERATIONS BABCOCK AND WILCOX PROCESS AT 90 PERCENT OPERATING CAPACITY

ITEM DESCRIPTION	UNITS	NET REQUIREMENTS	ANNUAL REQUIREMENTS	COST PER UNIT	ANNUAL COST ($\times 10^6$)
FEEDSTOCK: (KENTUCKY #9 SEAM, DEEP MINE)*	MMBTU	1.098×10^5 MMBTU/DAY	3.607×10^7 MMBTU/YEAR	\$1.25/ MMBTU	\$45.087
CATALYST & CHEMICAL MAKE-UP					\$ 236
SUBTOTAL FEEDSTOCK & CATALYST & CHEMICALS					\$45.323
ELECTRIC POWER - PK/AVG. LOAD FACTOR = 1.5	KWH	5,800 KW	45,727,200 KWH/YEAR	\$0.027/ KWH	.735
WATER	KGAL	4,000,320 GAL/DAY	1,314,100,000 GAL/YEAR	\$	\$ 1.051
OPERATING LABOR	PERSON HRS.	141,024 HRS./YEAR	141,024 HRS./YEAR	\$12.16/ HR.	\$ 1.715
OPERATING SUPPLIES		(15% OF O.L.)			\$.257
MAINTENANCE LABOR		(1.6% OF 1/4 OF TFI)			\$ 9.749
MAINTENANCE SUPPLIES		(2.4% OF 1/4 OF TFI)			\$14.623
SUPERVISION	PERSON HRS.	29,952 HRS./YEAR	29,952 HRS.	\$18.83/ HR.	\$.564
GENERAL PLANT STAFF		(30% OF O.L. AND M.L. AND SUP)			\$ 3.608
ADMINISTRATION AND GENERAL OVERHEAD		(5% OF O&M LESS FEEDSTOCK AND CHEM.)			\$ 1.640
PROPERTY TAXES AND INSURANCE					-0-
GROSS ANNUAL OPERATING & MAINTENANCE COSTS					\$34.442
BYPRODUCTS CREDITS					-0-
NET ANNUAL OPERATING & MAINTENANCE COSTS					\$34.442
TOTAL FEEDSTOCK, CAT & CHEM & O&M COSTS					\$79.765

* MEAN BTU VALUE OF FEEDSTOCK = 10,980 BTU/LB.

THE BDM CORPORATION

d. Babcock and Wilcox Present Value of Costs, Product Prices, and Cash Flow

THE BDM CORPORATION

PRESENT VALUE OF CAPITAL AND OPERATING AND MAINTENANCE COSTS

HARPOCK 1 WILCON

MILLIONS OF DOLLARS

ITEM DESCRIPTION	GENERAL FACILITY	MODULE 1	MODULE 2	MODULE 3	MODULE 4	TOTAL FACILITY
OPERATING AND MAINTENANCE EXPENSES						
FEEDSTOCK	0.00	496.95	477.68	468.11	458.81	1901.54
CATALYST & CHEMICALS	0.00	2.60	2.50	2.45	2.40	9.95
SUBTOTAL	0.00	499.55	480.18	470.56	461.21	1911.50
ELECTRIC POWER	0.00	12.23	11.68	11.42	11.18	46.52
WATER	0.00	4.22	3.77	3.55	3.36	14.90
OPERATING LABOR	0.00	17.60	16.90	16.56	16.23	67.30
OPERATING SUPPLIES	0.00	2.64	2.54	2.48	2.43	10.09
MAINTENANCE LABOR	0.00	102.75	98.65	96.63	94.69	392.71
MAINTENANCE SUPPLIES	0.00	150.17	147.98	144.64	142.03	584.82
SUPERVISION	0.00	5.79	5.56	5.45	5.34	22.13
GENERAL PLANT	0.00	37.04	35.57	34.85	34.15	141.60
ADMIN. & GENERAL	0.00	16.83	16.17	15.64	15.52	64.37
PROPERTY TAXES & INS	0.00	0.00	0.00	0.00	0.00	0.00
BYPRODUCT REV	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL	0.00	353.21	338.81	331.73	324.94	1348.69
SUBTOTAL O&M COSTS	0.00	852.76	818.99	802.28	786.15	3260.18
CAPITAL COSTS						
DEPRECIABLE INVESTMENT COST	172.99	664.57	632.78	627.30	617.61	2714.85
NON-DEPRECIABLE INVESTMENT COST	1.40	12.95	12.60	12.04	12.15	51.16
SUBTOTAL CAPITAL COSTS	173.99	677.52	645.38	639.36	629.76	2766.01
TOTAL PRESENT VALUE OF CAPITAL AND OPERATING AND MAINTENANCE COSTS	173.99	1530.28	1464.37	1441.64	1415.91	6026.19
ANNUAL PRODUCT (MMBTU)		24883284	24883284	24883284	24883284	
PRODUCT PRICE (\$/MMBTU) (JANUARY 1980 DOLLARS)						\$ 4.39
PRODUCT PRICE (\$/MMBTU) (CURRENT DOLLARS)						\$ 17.11

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THE BDM CORPORATION

BABCOCK & WILCOX PROCESS

FISCAL YEAR CASH FLOW SUMMARY - CONSTANT 1980 DOLLAR PRICE SCHEME

FISCAL YEAR	CAPITAL INVESTMENT	O&M	CAPITAL RECOVERY	TOTAL COSTS	REVENUE	CASH FLOW
1980	16.09	0.00	0.00	16.09	0.00	-16.09
1981	70.30	0.00	0.00	70.30	0.00	-70.30
1982	284.41	0.00	0.00	284.41	0.00	-284.41
1983	704.67	0.00	0.00	704.67	0.00	-704.67
1984	1068.02	0.00	0.00	1068.02	0.00	-1068.02
1985	964.54	43.12	63.24	1070.90	79.50	-991.40
1986	527.00	131.29	168.38	826.67	238.51	-588.16
1987	123.37	308.48	353.95	785.80	556.52	-229.28
1988	0.00	354.90	378.75	733.65	636.02	-97.63
1989	0.00	357.25	353.91	711.16	636.02	-75.14
1990	0.00	359.68	330.71	690.39	636.02	-54.37
1991	0.00	362.20	309.12	671.32	636.02	-35.30
1992	0.00	364.76	288.86	653.62	636.02	-17.60
1993	0.00	367.35	269.93	637.78	636.02	-1.26
1994	0.00	369.96	252.32	622.28	636.02	13.74
1995	0.00	372.61	235.82	608.43	636.02	27.59
1996	0.00	375.29	220.37	595.66	636.02	40.36
1997	0.00	375.91	205.96	581.87	636.02	54.15
1998	0.00	376.55	192.47	569.02	636.02	67.00
1999	0.00	377.20	179.88	557.08	636.02	78.94
2000	0.00	377.85	168.15	546.43	636.02	89.59
2001	0.00	378.52	157.14	535.66	636.02	100.36
2002	0.00	379.19	146.84	526.03	636.02	109.99
2003	0.00	379.87	137.25	517.12	636.02	118.90
2004	0.00	380.55	128.28	508.83	636.02	127.19
2005	0.00	333.59	103.54	437.13	556.52	119.39
2006	0.00	238.72	68.51	307.23	397.51	90.28
2007	0.00	47.83	13.25	61.08	79.50	18.42

All Figures in Millions of Constant Fiscal 1980 Dollars

THE BDM CORPORATION

4. BGC-Lurgi MBG

THE BDM CORPORATION

a. BGC-Lurgi System Costs

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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 1-COAL PREPARATION & FEED

UNIT OPERATION NUMBER: 11

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: N/A

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

INCLUDED IN FOLLOWING SHEETS FOR SYSTEM 2

COMPUTATION METHOD: N/A

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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS. BGC-LURGI

SYSTEM: 2-GASIFICATION

UNIT OPERATION NUMBER: 11

SUBSYSTEM: GASIFIERS

REFERENCE SOURCE FOR COSTING:

- (1) EPRI-642 CASE MXSC
GASIFIER + ASH HANDLING
- (2) EPRI-244 CASE MA
GASIFIER + ASH HANDLING

REFERENCE SYSTEM COST:

- (1) \$49,628,000 MID - '76 DOLLARS
(INSTALLED) GASIFIER + ASH HANDLING
- (2) $\$66.21 \times 10^6$ MID - '75 DOLLARS
GASIFIER + ASH HANDLING

REFERENCE CAPACITY: 6 OPERATING GASIFIERS + 2 SPARES;
ASH CAPACITY = 1,000 TONS/DAY

TVA CAPACITY: 2 OPERATING GASIFIERS + 1 SPARE;
ASH CAPACITY = 980 TONS/DAY

RECOMMENDED CAPACITY EXPONENT:

- (1) GASIFIERS = $\left(\frac{3}{8}\right)^1$
- (2) ASH HANDLING = 0.6

EXPLANATORY COMMENTS:

1. SOME OF THE FOLLOWING COMPUTATION WAS PERFORMED TO REMOVE ASH HANDLING FROM A TOTAL REFERENCE COST. THE PERCENT ASH HANDLING WAS KNOWN FROM THE EPRI-244, CASE MA.

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = $\frac{3}{8} \times [\text{REFERENCE COST (642,MXSC)} - \text{ASH HANDLING COST (244,MA)}] \times \text{ESCALATION FACTOR}$

ASH HANDLING COST (244,MA) = $0.2163 \times (\text{AF-244 MA REFERENCE COST FOR GASIFICATION AND ASH HANDLING}) \times \text{CAPACITY FACTOR} \times \text{ESCALATION FACTOR (244,MA)}$

THE BDM CORPORATION

SYSTEM COST DATA (CONTINUED)

INPUTS:

REFERENCE SYSTEM COSTS (642, MXSC) = \$49,628,000 (MID '76 DOLLARS)

REFERENCE SYSTEM COSTS (244, MA) = $\$66.21 \times 10^6$ (MID-'75 DOLLARS)

ESCALATION FACTOR (244, MA) = 1.053 (TO JANUARY '76 DOLLARS FROM
MID-75 DOLLARS)

CAPACITY FACTOR = $(980/1000)^{0.6}$

ESCALATION FACTOR = 1.30 (TO JAN. '80 DOLLARS FROM JAN '76 DOLLARS)

ASH HANDLING COST (244, MA) = $0.2163 \times \$66.21 \times 10^6 \times$
 $(980/1000)^{0.6} \times 1.053 = \14.90×10^6 (MID - '76 DOLLARS)

RESULTS:

TOTAL SUBSYSTEM COST = $\$16.93 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI
SYSTEM: 2-GASIFICATION
UNIT OPERATION NUMBER: 21
SUBSYSTEM: ASH HANDLING
REFERENCE SOURCE FOR COSTING: EPRI-244, CASE MA
REFERENCE SYSTEM COST: $\$66.21 \times 10^6$ (MID '75 DOLLARS)
REFERENCE CAPACITY: 1,000 TPD
TVA CAPACITY: 730 TPD
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = PROPORTION OF REFERENCE SYSTEM COST (RSC) x
REFERENCE SYSTEM COST x CAPACITY FACTOR x ESCALATION FACTOR

INPUTS:

REFERENCE SYSTEM COST = $\$66.21 \times 10^6$ (MID '75 DOLLARS)
PROPORTION OF RSC = .2163
CAPACITY FACTOR = $(730/1000)^{0.6} = .82$
ESCALATION FACTOR = 1.37 (FROM MID '75 DOLLARS TO JAN. '80 DOLLARS)

RESULTS:

TOTAL SUBSYSTEM COST = $\$16.25 \times 10^6$ (JAN. '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BGC-LURGI PROCESS, SYSTEM NO. 2, GASIFICATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM GASIFIERS	\$ 16.93	\$ 16.93	\$ 16.93	\$ 16.93
SUBSYSTEM ASH HANDLING	\$ 16.25	\$ 16.25	\$ 16.25	\$ 16.25
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 33.18	\$ 33.18	\$ 33.18	\$ 33.18
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. GASIFIERS ¹	\$ 2.54	\$ 2.54	\$ 2.54	\$ 2.54
SUBSYSTEM NO. ASH HANDLING ²	\$ 0.81	\$ 0.81	\$ 0.81	\$ 0.81
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 3.35	\$ 3.35	\$ 3.35	\$ 3.35
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 36.53	\$ 36.53	\$ 36.53	\$ 36.53

- 1 15% PROCESS CONTINGENCY
2 5% PROCESS CONTINGENCY

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI
SYSTEM: 3-GAS COOLING
UNIT OPERATION NUMBER: 21
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: EPRI AF-642 CASE MXSC
REFERENCE SYSTEM COST: $\$8.94 \times 10^6$ (MID '76 DOLLARS)
REFERENCE CAPACITY: 109.8×10^6 BTU/HR
TVA CAPACITY: 130.9×10^6 BTU/HR
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

$$\text{TVA SYSTEM COST} = \frac{\text{EPRI COST}}{3} \times \left(\frac{\text{TVA BTU/HR}}{\text{EPRI BTU/HR}} \right)^{0.6}$$

$$\text{TOTAL SYSTEM COST} = \text{TVA SYSTEM COST} \times \text{ESCALATION FACTOR}$$

INPUTS:

$$\text{EPRI COST} = \$8.94 \times 10^6 \text{ (MID '76 DOLLARS)}$$

$$\text{CAPACITY FACTOR} = \left(\frac{130.9}{109.8} \right)^{0.6}$$

$$\text{ESCALATION FACTOR} = 1.30 \text{ (1976 TO 1980 DOLLARS)}$$

RESULTS:

$$\text{TVA SYSTEM COST} = \$3.31 \times 10^6 \text{ (MID '76 DOLLARS)}$$

$$\text{TOTAL SYSTEM COST} = \$4.3 \times 10^6 \text{ (JAN. '80 DOLLARS)}$$

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
BGC-LURGI PROCESS, SYSTEM NO. 3, GAS COOLING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 4.3	\$ 4.3	\$ 4.3	\$ 4.3
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 4.3	\$ 4.3	\$ 4.3	\$ 4.3

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI
SYSTEM: 4-ACID GAS REMOVAL (SELEXOL)
UNIT OPERATION NUMBER: 22
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: EPRI AF-916 CASE 4B
REFERENCE SYSTEM COST: \$54,227,000 (MID '76 DOLLARS)
REFERENCE CAPACITY: 407,775 ACFH
TVA CAPACITY: 389,204.1 ACFH
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST x CAPACITY FACTOR x
EXCALATION FACTOR

INPUTS:

REFERENCE SYSTEM COST = \$54,227,000 (MID '76 DOLLARS)

CAPACITY FACTOR = $1/3 \times \left(\frac{TVA \text{ ACFH}}{EPRI \text{ ACFH}} \right)^{0.6}$

$$1/3 \times (389,204.1/407,775)^{0.6} = .324$$

ESCALATION FACTOR = 1.30 (TO JANUARY '80 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$22.86 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BGC-LURGI PROCESS, SYSTEM NO. 4, ACID GAS REMOVAL SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 22.86	\$ 22.86	\$ 22.86	\$ 22.86
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. 5%				
SUBSYSTEM NO. _____	\$ 1.14	\$ 1.14	\$ 1.14	\$ 1.14
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 1.14	\$ 1.14	\$ 1.14	\$ 1.14
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 24.00	\$ 24.00	\$ 24.00	\$ 24.00

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI
SYSTEM: 5-SULFUR RECOVERY & TAIL GAS TREATING
UNIT OPERATION NUMBER: 36
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: DOE REPORT FE-1775-18, PLANT 2
REFERENCE SYSTEM COST: 9,032,000 (MID '77 DOLLARS)
(TOTAL DIRECT COSTS)
REFERENCE CAPACITY: 181.2 LT/D SULFUR PRODUCT
TVA CAPACITY: 179.4 LT/D
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. PROCESS NOTE: NORMAL OPERATING RATE OF PLANT 2 IS 240 M/H FEED ALTHOUGH DESIGN IS 527.5 M/H
2. PROVIDE 2 TRAINS FOR MODULE 1; 1 OPERATING PLUS 1 SPARE, AND 1 TRAIN FOR EACH ADDITIONAL MODULE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR) \times
CAPACITY FACTOR \times ESCALATION FACTOR

INPUTS:

TOTAL DIRECT COSTS: $\$9.032 \times 10^6$ (JAN. '77 DOLLARS)
INDIRECT COST FACTOR: 0.10 (INCLUDES INDIRECT CONSTRUCTION ENGINEERING/
HOME OFFICE COSTS)
CAPACITY FACTOR: $(179.4/181.2)^{0.6} = .994$
ESCALATION FACTOR: 1.22 (TO JANUARY '80 DOLLARS)

RESULTS:

TOTAL SYSTEM COST (MODULE 1): $\$24.08 \times 10^6$
TOTAL SYSTEM COST (MODULE 2-4): $\$12.04 \times 10^6$

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BGC-LURGI PROCESS, SYSTEM NO. 5, SULFUR RECOVERY

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 24.08	\$ 12.04	\$ 12.04	\$ 12.04
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 3.61	\$ 1.81	\$ 1.81	\$ 1.81
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 27.69	\$ 13.85	\$ 13.85	\$ 13.85

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 6-AIR SEPARATION PLANT

UNIT OPERATION NUMBER: 80

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: MITTELHAUSER COST CURVES (ENCLOSED WITH LURGI)

REFERENCE SYSTEM COST: $\$34.75 \times 10^6$ (JAN. '80 DOLLARS) EACH PLANT (5 REQUIRED)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 5 @ 1656 TPD @ 514.7 psia O_2

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

2 INSTALLED WITH FIRST MODULE AND 1 WITH EACH ADDITIONAL MODULE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = NO. OF UNITS \times REFERENCE SYSTEM COST
MODULE 1 = 2 \times REFERENCE SYSTEM COST
MODULE 2-4 = REFERENCE SYSTEM COST (PER MODULE)

INPUTS:

REFERENCE SYSTEM COST: $\$34.75 \times 10^6$ (JAN. '80 DOLLARS)

RESULTS:

TOTAL MODULE 1 COST: $\$69.50 \times 10^6$ (JANUARY '80 DOLLARS)
TOTAL MODULES 2-4 COST: $\$34.75 \times 10^6$ (JANUARY '80 DOLLARS)
TOTAL FACILITY COST: $\$173.75 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BGC-LURGI PROCESS, SYSTEM NO. 6, AIR SEPARATION PLANT

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 69.50	\$ 34.75	\$ 34.75	\$ 34.75
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 69.50	\$ 34.75	\$ 34.75	\$ 34.75

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI
SYSTEM: 7-COMPRESSION
UNIT OPERATION NUMBER: 23
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA, p. 167
REFERENCE SYSTEM COST: (SEE BELOW)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SYSTEM COST = EQUIPMENT COST x MODULAR FACTOR

INPUTS:

EQUIPMENT COST: $\$0.6324 \times 10^6$ (JANUARY '80 DOLLARS)
MODULAR FACTOR: 2.21 (INCLUDES MATERIAL, LABOR, INDIRECT COSTS)

RESULTS:

TOTAL SYSTEM COST = \$1.398 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BGC-LURGI PROCESS, SYSTEM NO. 7, COMPRESSION

SYSTEM CAPITAL INVESTMENT TABLE

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 1.398	\$ 1.398	\$ 1.398	\$ 1.398
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	-0-	-0-	-0-	-0-
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 1.398	\$ 1.398	\$ 1.398	\$ 1.398

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	BGC-LURGI
<u>SYSTEM:</u>	8-PROCESS SOLIDS TREATMENT
<u>UNIT OPERATION NUMBER:</u>	31
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	MITTELHAUSER IN-HOUSE COST ESTIMATE
<u>REFERENCE SYSTEM COST:</u>	$\$.265 \times 10^6$ (JANUARY '80 DOLLARS) (TOTAL DIRECT COSTS)
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	N/A

TOTAL SYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS = $\$.265 \times 10^6$
INDIRECT FACTOR = 0.37 (75/25 ASSUMED M/L RATIO FOR CHEMICAL PROCESSES)

RESULTS:

TOTAL SYSTEM COST = $\$.363 \times 10^6$ (JAN. '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BGC-LURGI PROCESS, SYSTEM NO. 8, PROCESS SOLIDS TREATMENT

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$.363	\$.363	\$.363	\$.363
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$.363	\$.363	\$.363	\$.363

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 10-INSTRUMENTATION & CONTROL

UNIT OPERATION NUMBER: N/A

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: VENDOR ESTIMATE FROM GENERAL ELECTRIC

REFERENCE SYSTEM COST: \$1.5 MILLION FOR A SYSTEM WITH CAPACITY SUFFICIENT FOR TVA NEEDS. IT IS BASED UPON A HONEYWELL 4500 SYSTEM.

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS SYSTEM CONTAINS JUST THE NECESSARY MATERIAL FOR THE CENTRALIZED REMOTE FACILITY. IT CONTAINS SUFFICIENT CABLE TO TRANSMIT SIGNALS FROM THE PROCESS UNITS, DATA PROCESSING EQUIPMENT, SOFTWARE PACKAGES FOR THE ANALYSIS OF INCOMING DATA, AND DISPLAY PANELS FOR PRESENTATION OF DATA. THIS SYSTEM DOES NOT INCLUDE LOCAL CONTROLS FOR DIRECT OPERATION OF INDIVIDUAL SYSTEMS.

COMPUTATION METHOD:

TOTAL DIRECT COST = (1 + INSTALLATION FACTOR) x REFERENCE COST
TOTAL SYSTEM COST = (1 + INDIRECT COST FACTOR) x TOTAL DIRECT COST

INPUTS:

FIELD INSTALLATION FACTOR = 1.10 (ASSUMED)

TOTAL DIRECT COSTS = $\$3.15 \times 10^6$ (JANUARY '80 DOLLARS)

INDIRECT COST FACTOR = 0.289 (90/10 ASSUMED M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = $\$4.060 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BGC-LURGI PROCESS, SYSTEM NO. 10, INSTRUMENTATION & CONTROL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS	\$ 4.06	\$ 4.06	\$ 4.06	\$ 4.06
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 4.06	\$ 4.06	\$ 4.06	\$ 4.06
 TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$.61	\$.61	\$.61	\$.61
 TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 4.67	\$ 4.67	\$ 4.67	\$ 4.67

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 11-COAL HANDLING

UNIT OPERATION NUMBER: 10

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: RESOURCE ENGINEERING INC. - ESTIMATE BASED ON IN-HOUSE COST DATA. SEE DETAILED EQUIPMENT LISTING WHICH FOLLOWS.

REFERENCE SYSTEM COST: $\$48.1 \times 10^6$ JANUARY '80 DOLLARS (TOTAL DIRECT COSTS)

REFERENCE CAPACITY: 20,000 TPD

TVA CAPACITY: 30.440 TPD

RECOMMENDED CAPACITY EXPONENT: 0.35

EXPLANATORY COMMENTS:

THIS SYSTEM IS SIZED TO SERVE THE NEEDS OF FOUR (4) MODULES TO BE BUILT ON THE TVA FACILITY.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

TOTAL DIRECT COST (E+M+L) = REFERENCE COST $\times \left(\frac{\text{TVA CAPACITY}}{\text{REF CAPACITY}} \right)^{.35}$

INPUTS:

INDIRECT COST FACTOR = .335 (80/20 ASSUMED M/L RATIO FOR SOLIDS HANDLING)

CAPACITY FACTOR = $\left(\frac{30,440}{20,000} \right)^{.35} = 1.158$

RESULTS:

TOTAL DIRECT COST (E+M+L) = $\$55.7 \times 10^6$ (JAN. '80 DOLLARS)

TOTAL SYSTEM COST (TVA) = $\$74.36 \times 10^6$ (JAN. '80 DOLLARS)

THE BDM CORPORATION

SYSTEM 11

COAL HANDLING

(EQUIPMENT FACTORED COSTS)

<u>DESCRIPTION</u>	<u>JAN '80 \$ x (10⁶)</u>
1. Continuous barge unloader, elevator type, 3000-3500 TPH, including dock, moorings, surge bin, conveyors.	\$ 10.0
2. Open coal storage piles, 1.8 x 10 ⁶ tons. Double windows 100' high x (2 x 240') wide x 2,800'. Costs for site preparation, stockpiling conveyors, stacker/reclaiming equipment, mobile equipment.	30.0
3. Rotary brakers, three (2N, 1S), 1,000 TPH each 50 hp each, 12' d x 22' each.	1.0
4. Concrete silos, four, 11,750 tons each, 67' d x 150' each.	6.0
5. Truck dump hopper, 2,000 tons.	0.2
6. Conveyors not included above.	0.3
a. Truck station to crusher, 500 TPH 36" x 500 ft., 0 elevation, 426 fpm, 32 hp.	
b. Crusher to silos, 2,160 TPH 60" x 700 ft., 150 ft. elevation, 470 hp, 600 fpm.	<u>0.6</u>
TOTAL DIRECT COSTS (E+M+L) =	\$ 48.1

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BGC-LURGI PROCESS, SYSTEM NO. 11, COAL HANDLING SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>GENERAL FACILITIES</u>
TOTAL DIRECT PLUS INDIRECT COSTS SUBTOTAL:	\$ 74.36
TOTAL PROCESS CONTINGENCY SUBTOTAL:	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 74.36

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 12-SOLIDS WASTE RECYCLING/DISPOSAL

UNIT OPERATION NUMBER: 81

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATE (FROM IN-HOUSE COST DATA BASE)

REFERENCE SYSTEM COST: $\$16.1 \times 10^6$ (JANUARY '80 DOLLARS)
(TOTAL DIRECT COSTS)
NOTE: DIRECT COST OF SOLIDS DISPOSAL AREA = $\$10 \times 10^6$
DIRECT COST OF RUNOFF COLLECTION BASIN = $\frac{6.1 \times 10^6}{16.1 \times 10^6}$

REFERENCE CAPACITY: N/A

TVA CAPACITY: 61,000 #/HR SOLIDS (DRY), 2319 GAL/HR, H₂O W/SOLIDS

RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

1. SYSTEM IS ESSENTIALLY AN EXCAVATED 20-YEAR AREA FOR SOLIDS DISPOSAL. INCLUDES EXCAVATION AND CONSTRUCTION OF CLAY LINED DISPOSAL AREAS AND RUNOFF HOLD POND.
2. LAND COSTS ARE NOT INCLUDED.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

INDIRECT COST FACTOR = 0.335 (80/20 ASSUMED M/L RATIO FOR SOLIDS HANDLING)

TOTAL DIRECT COST = $\$16.1 \times 10^6$

RESULTS:

TOTAL SYSTEM COST = $\$21.494 \times 10^6$ (JANUARY '80 DOLLARS) FOR SINGLE
MOD E

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BGC-LURGI PROCESS, SYSTEM NO. 12, SOLIDS WASTE RECYCLING/DISPOSAL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS	\$ 21.49	\$ 21.49	\$ 21.49	\$ 21.49
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 21.49	\$ 21.49	\$ 21.49	\$ 21.49
 TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
 <u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 21.49	\$ 21.49	\$ 21.49	\$ 21.49

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	BGC-LURGI
<u>SYSTEM:</u>	13-BYPRODUCTS PROCESSING
<u>UNIT OPERATION NUMBER:</u>	R3-SULFUR STORAGE & LOADING
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	MITTELHAUSER IN-HOUSE COST DATA BASE
<u>REFERENCE SYSTEM COST:</u>	$\$1 \times 10^6$ (JANUARY '80 DOLLARS)
<u>REFERENCE CAPACITY:</u>	N/A
<u>I/A CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	

TOTAL SYSTEM COST = $\$1 \times 10^6$ (JAN. '80 DOLLARS) FOR EACH MODULE

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BGC-LURGI PROCESS, SYSTEM NO. 13, BYPRODUCTS PROCESSING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
UNIT OPERATION: 83-SULFUR STORAGE AND LOADING				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 1.00	\$ 1.00	\$ 1.00	\$ 1.00
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 1.00	\$ 1.00	\$ 1.00	\$ 1.00

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 14-PLANT POWER SYSTEM

UNIT OPERATION NUMBER: 87

SUBSYSTEM: DISTRIBUTION COSTS FOR INTERNALLY GENERATED POWER

REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA, FROM
PROCESS PLANT EVALUATION AND CONTROL,
p. 363

REFERENCE SYSTEM COST: $\$12.1 \times 10^6$ (DIRECT + INDIRECT)
('78 DOLLARS)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 17,200 KW

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST \times ESCALATION FACTOR₂
(1978 TO 1980 DOLLARS)
DISTRIBUTION COST = KILOWATT REQUIREMENT \times TOTAL DIRECT COST FACTOR \times
(INDIRECT COST FACTOR +1) \times ESCALATION FACTOR₁ (1970 TO 1980 DOLLARS)

INPUTS:

KILOWATT REQUIREMENT = 17,200 kw
DIRECT COST FACTOR = \$102.62 (1970 DOLLARS/KILOWATT)
INDIRECT COST FACTOR = 0.49 (BASED ON 0.72 L/M RATIO)
ESCALATION FACTOR₁ = 1.998 (FROM 1970 BASE YEAR DOLLARS)
ESCALATION FACTOR₂ = 1.14 (FROM 1978 BASE YEAR DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$13.79 \times 10^6$ (JAN. 80 DOLLARS)
DISTRIBUTION COST = 5.16×10^6 (JAN. '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 14-PLANT POWER

UNIT OPERATION NUMBER: 87

SUBSYSTEM: DISTRIBUTION COST FOR EXTERNALLY
GENERATED POWER

REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA, FROM
PROCESS PLANT EVALUATION AND CONTROL,
p. 363

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: 21,275 kw

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS SYSTEM CONTAINS NO POWER GENERATING CAPACITY. SYSTEMS COSTS
REPRESENT ONLY CAPITAL REQUIREMENTS FOR POWER DISTRIBUTION.

COMPUTATION METHOD:

TOTAL SYSTEM COST = KILOWATT REQUIREMENT x TOTAL DIRECT COST FACTOR x
(1 + INDIRECT COST FACTOR) x ESCALATION FACTOR

INPUTS:

KILOWATT REQUIREMENT = 21,275 kw
TOTAL DIRECT COST FACTOR = \$102.62 (1970 DOLLARS/PER KILOWATT)
INDIRECT COST FACTOR = 0.469 (BASED ON 0.72 L/M RATIO)
ESCALATION FACTOR = 1.988 (FROM 1970 BASE YEAR DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$6.376 x 10⁶

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BGC-LURGI PROCESS, SYSTEM NO. 14, PLANT POWER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS	\$ 13.79	\$ 13.79	\$ 13.79	\$ 13.79
UNIT OPERATION: DISTRIBUTION COST				
FOR INTERNALLY GENERATED POWER	\$ 5.16	\$ 5.16	\$ 5.16	\$ 5.16
UNIT OPERATION: DISTRIBUTION COST				
FOR EXTERNALLY GENERATED POWER	\$ 6.376	\$ 6.376	\$ 6.376	\$ 6.376
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 25.326	\$ 25.326	\$ 25.326	\$ 25.326

TOTAL PROCESS CONTINGENCY

SUBSYSTEM NO. _____	
SUBSYSTEM NO. _____	
SUBSYSTEM NO. _____	
SUBSYSTEM NO. _____	
SUBSYSTEM NO. _____	
SUBSYSTEM NO. _____	
<u>SUBTOTAL:</u>	-0-

<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 25.326	\$ 25.326	\$ 25.326	\$ 25.326
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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 15-STEAM GENERATION/DISTRIBUTION

UNIT OPERATION NUMBER: 84

SUBSYSTEM: STEAM & CONDENSATE

REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST ESTIMATE

REFERENCE SYSTEM COST: $\$4.1 \times 10^6$ (MID-'78, W/O INDIRECTS)+
 $\$4.3 \times 10^6$ (MID-'78, W/INDIRECTS)
 $\$4.1 \times 10^6 \times 1.36 + 4.3 \times 10^6 = \9.9×10^6
(MID-'78 DOLLARS)

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = REFERENCE SYSTEM COST \times ESCALATION FACTOR

INPUTS:

ESCALATION FACTOR = 1.14 (1978 TO 1980 DOLLARS)
REFERENCE SYSTEM COST = $\$9.9 \times 10^6$

RESULTS:

TOTAL SUBSYSTEM COST = $\$11.29 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 15-STEAM GENERATION/DISTRIBUTION

UNIT OPERATION NUMBER: 86

SUBSYSTEM: FLUE GAS TREATMENT

REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST ESTIMATE

REFERENCE SYSTEM COST: $\$10.8 \times 10^6$ (NOVEMBER 1977 DOLLARS)
(TOTAL DIRECT COSTS)

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

$$\text{TOTAL SUBSYSTEM COST} = \text{TOTAL DIRECT COST} \times (1 + \text{INDIRECT COST FACTOR}) \times \text{ESCALATION FACTOR}$$

INPUTS:

TOTAL DIRECT COST = $\$10.8 \times 10^6$
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)
ESCALATION FACTOR = 1.14

RESULTS:

TOTAL SUBSYSTEM COST = $\$16.74 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 15-STEAM GENERATION/DISTRIBUTION

UNIT OPERATION NUMBER: 84

SUBSYSTEM: DISTRIBUTION

REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA PROCESS PLANT
ESTIMATING, EVALUATION AND CONTROL, p. 365

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = STEAM REQUIREMENT \times (1 + TOTAL DIRECT COST
FACTOR) \times (1 + INDIRECT COST FACTOR) \times ESCALATION FACTOR (1970 TO
1980 DOLLARS)

INPUTS:

STEAM REQUIREMENT = 600,000 LBS/HR
TOTAL DIRECT COST FACTOR = 0.68 (1970 DOLLARS PER LBS/HR)
INDIRECT COST FACTOR = 0.488 (BASED ON AN L/M RATIO OF 0.82)
ESCALATION FACTOR = 1.988

RESULTS:

TOTAL SUBSYSTEM COST = $\$2.982 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BGC-LURGI PROCESS, SYSTEM NO. 15, STEAM GENERATION AND DISTRIBUTION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
UNIT OPERATION: STEAM GENERATION				
CONDENSATE	\$ 11.29	\$ 11.29	\$ 11.29	\$ 11.29
UNIT OPERATION: FLUE GAS	\$ 16.74	\$ 16.74	\$ 16.74	\$ 16.74
UNIT OPERATION: DISTRIBUTION	\$ 2.98	\$ 2.98	\$ 2.98	\$ 2.98
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 31.01	\$ 31.01	\$ 31.01	\$ 31.01
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 31.01	\$ 31.01	\$ 31.01	\$ 31.01

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 16-WATER SUPPLY

UNIT OPERATION NUMBER: 85

SUBSYSTEM: RAW H₂O CLARIFIER

REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
(SEE BELOW)

REFERENCE SYSTEM COST: \$.522 x 10⁶ (JANUARY '80 DOLLARS)
(TOTAL DIRECT COSTS) (SEE BELOW)

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)
CONTINGENCY = TOTAL SYSTEM COST x CONTINGENCY FACTOR

INPUTS:

TOTAL DIRECT COSTS	
FIRE POND	\$120,000
CLARIFIER	317,000
RECARBONATOR	27,000
CHEM FEED	50,000
	<u>\$522,000</u>

CONTINGENCY FACTOR (INCLUDES PUMPS) = 15%
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED M/L RATIO)

RESULTS:

TOTAL SUBSYSTEM COST = \$.709 x 10⁶

CONTINGENCY = \$.106 x 10⁶

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI
SYSTEM: 16-WATER SUPPLY
UNIT OPERATION NUMBER: 85
SUBSYSTEM: DEMINERALIZERS
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
(SEE BELOW)
REFERENCE SYSTEM COST: $\$3.413 \times 10^6$ (JANUARY '80 DOLLARS)
(TOTAL DIRECT COSTS) (SEE BELOW)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS - CONTINGENCY₁) x
(1 + INDIRECT COST FACTOR)
CONTINGENCY₂ = TOTAL SYSTEM COST x CONTINGENCY₂ FACTOR

INPUTS:

TOTAL DIRECT COSTS:	
FILTERS	\$ 100,000
DEMINERALIZERS	2,260,000
CHEM STORAGE TANKS	53,000
CONTINGENCY ₁	100,000
	<u>\$3,413,000</u>

CONTINGENCY₂ = 15%

INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)

RESULTS:

TOTAL SUBSYSTEM COST = \$4,505,680 (JANUARY '80 DOLLARS)

CONTINGENCY₂ = $\$.23 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BGC-LURGI PROCESS, SYSTEM NO. 16, WATER SUPPLY

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM CLARIFIER	\$ 0.709	\$ 0.709	\$ 0.709	\$ 0.709
SUBSYSTEM DEMINERALIZER	\$ 4.51	\$ 4.51	\$ 4.51	\$ 4.51
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 5.219	\$ 5.219	\$ 5.219	\$ 5.219
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. CLARIFIER (15%)	\$.106	\$.106	\$.106	\$.106
SUBSYSTEM NO. DEMINERALIZER (5%)	\$.23	\$.23	\$.23	\$.23
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$.336	\$.336	\$.336	\$.336
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 5.555	\$ 5.555	\$ 5.555	\$ 5.555

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 17-COOLING WATER

UNIT OPERATION NUMBER: 39

SUBSYSTEM: COOLING TOWER

REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
(SAME AS K-T 5.2.1 CASE)

REFERENCE SYSTEM COST: $\$4.0 \times 10^6$ (JANUARY '80 DOLLARS)
(TOTAL DIRECT COST)

REFERENCE CAPACITY: 75,000 GPM

TVA CAPACITY: 57,206 GPM

RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

$$\text{TOTAL SUBSYSTEM COST} = \text{TOTAL DIRECT COSTS} \times (1 + \text{INDIRECT COST FACTOR})$$

$$\text{TOTAL DIRECT COST} = \text{REFERENCE SYSTEM COST} \times \left(\frac{\text{TVA CAPACITY}}{\text{REF CAPACITY}} \right)^{0.6}$$

INPUTS:

$$\text{TOTAL DIRECT COST} = \$4 \times 10^6 \times (57206/75000)^{0.6}$$

$$= 4 \times 10^6 \times .850 \text{ (CAPACITY FACTOR)} = \$3.4 \times 10^6$$

$$\text{INDIRECT COST FACTOR} = 0.36 \text{ (75/25 ASSUMED "NORMAL" M/L RATIO)}$$

RESULTS:

$$\text{TOTAL SUBSYSTEM COST} = \$4.624 \times 10^6 \text{ (JANUARY '80 DOLLARS)}$$

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI
SYSTEM: 17-COOLING WATER
UNIT OPERATION NUMBER: 39
SUBSYSTEM: EVAPORATION
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: \$.400 (JANUARY '80 DOLLARS)
(TOTAL DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS: \$.400 $\times 10^6$
INDIRECT COST FACTOR: 0.36 (75/25 ASSUMED M/L RATIO)

RESULTS:

TOTAL SUBSYSTEM COST = \$0.544 $\times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

BGC-LURGI PROCESS, SYSTEM NO. 17, COOLING WATER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM: COOLING TOWER	\$ 4.624	\$ 4.624	\$ 4.624	\$ 4.624
SUBSYSTEM: EVAPORATOR	\$.400	\$.400	\$.400	\$.400
SUBSYSTEM NO. —				
SUBSYSTEM NO. —				
SUBSYSTEM NO. —				
SUBSYSTEM NO. —				
<u>SUBTOTAL:</u>	\$ 5.024	\$ 5.024	\$ 5.024	\$ 5.024
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. —				
SUBSYSTEM NO. —				
SUBSYSTEM NO. —				
SUBSYSTEM NO. —				
SUBSYSTEM NO. —				
SUBSYSTEM NO. —				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 5.024	\$ 5.024	\$ 5.024	\$ 5.024

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI
SYSTEM: 18-WASTE WATER TREATMENT
UNIT OPERATION NUMBER: 33
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: EPRI AF-244 CASE MA
REFERENCE SYSTEM COST: $\$61.69 \times 10^6$ (MID '75 DOLLARS)
REFERENCE CAPACITY: SEE BELOW
TVA CAPACITY: SEE BELOW
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = REFERENCE SYSTEM COST x CAPACITY FACTOR x
ESCALATION FACTOR

INPUTS:

REFERENCE SYSTEM COST = $\$61.69 \times 10^6$ (MID '75 DOLLARS)

$$\begin{aligned}\text{CAPACITY FACTOR} &= 0.535 \times \left(\frac{583,437.3}{2,512,167} \right)^{0.6} + 0.465 \times \left(\frac{111,806.7}{840,466} \right)^{0.6} \\ &= .223 + .138 = .36\end{aligned}$$

ESCALATION FACTOR = 1.37 (1975 TO 1980 DOLLARS)

RESULTS:

TOTAL SUBSYSTEM COST = $\$30.52 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 18-WASTE WASTE TREATMENT

UNIT OPERATION NUMBER: 37

SUBSYSTEM: BIOXIDATION

REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
(SEE BELOW)

REFERENCE SYSTEM COST: $\$2.156 \times 10^6$ (JANUARY '80 DOLLARS)
(TOTAL DIRECT COST)

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

$$\text{TOTAL SUBSYSTEM COST} = (\text{TOTAL DIRECT COST} - \text{CONTINGENCY}) \times (1 + \text{INDIRECT COST FACTOR})$$

INPUTS:

TOTAL DIRECT COST:	EQUALIZER BASIN	\$ 35,000	
	ARRATION	625,000	
	CLARIFIER	27,000	
	VACUUM FILTER	150,000	
	SAND FILTER	178,000	
	RO UNIT	700,000	
	CONTINGENCY	441,000	
	TOTAL	<u>\$2,156,000</u>	(INCLUDES PUMPS, CHEM. FEED EQUIP. FOR MIXED PROCESS AND INSTRUMENTS)

INDIRECT COST FACTOR: 0.36 (75/25 ASSUMED M/L RATIO)

RESULTS:

$$\text{TOTAL SUBSYSTEM COST} = \$2.35 \times 10^6 \text{ (JANUARY '80 DOLLARS)}$$

TPC BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI
SYSTEM: 18-WASTE WATER TREATMENT
UNIT OPERATION NUMBER: 37
SUBSYSTEM: CARBON CONTACTOR
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: $\$.525 \times 10^6$ (JANUARY '80 DOLLARS)
(TOTAL DIRECT COST)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COST = $\$.525 \times 10^6$
INDIRECT COST FACTOR = 0.37 (75/25 ASSUMED M/L RATIO FOR CHEMICAL PROCESSES)

RESULTS:

TOTAL SUBSYSTEM COST = $\$.72 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS BGC-LURGI PROCESS, SYSTEM NO. 18, WASTE WATER TREATMENT, PROCESS CONDENSATE PROCESSING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
UNIT OPERATION 33-PROCESS CON- DENSATE TREATING	\$ 30.520	\$ 30.520	\$ 30.52	\$ 30.52
UNIT OPERATION 37-BIOTREATMENT	\$ 2.35	\$ 2.35	\$ 2.35	\$ 2.35
SUBSYSTEM: CARBON CONTACTOR	\$.720	\$.720	\$.720	\$.720
<u>SUBTOTAL:</u>	\$ 33.59	\$ 33.59	\$ 33.59	\$ 33.59
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO.				
SUBSYSTEM 37-BIOTREATMENT (30%)	\$.71	\$.71	\$.71	\$.71
SUBSYSTEM NO.				
SUBSYSTEM NO.				
SUBSYSTEM NO.				
SUBSYSTEM NO.				
<u>SUBTOTAL:</u>	\$.71	\$.71	\$.71	\$.71
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 34.3	\$ 34.3	\$ 34.3	\$ 34.3

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: BGC-LURGI

SYSTEM: 19-BUILDING & SUPPORT FACILITIES

UNIT OPERATION NUMBER: 88

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: EVALUATION OF INTERMEDIATE - BTU COAL GASIFICATION SYSTEMS FOR RETROFITTING POWER PLANTS, EPRI AF-531, AUGUST 1977

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

INVESTMENT FOR SERVICE FACILITIES SUCH AS MAINTENANCE SHOPS, STORES, COMMUNICATIONS, SECURITY, AND OFFICES IS ESTIMATED AT 4.985% OF DIRECT INVESTMENT. THIS ESTIMATE WAS PREPARED BY TVA BASED ON THEIR CONSTRUCTION EXPERIENCE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT SYSTEM INVESTMENTS \times (.049)

WHERE:

1. TOTAL DIRECT COSTS = TOTAL SYSTEM CAPITAL INVESTMENT -
INDIRECT COSTS
2. = TSCI-TDSI \times INDIRECT COST FACTOR
3. = $\frac{1}{(1 + \text{INDIRECT COST FACTORS})} \times \text{TSCI}$

INPUTS:

INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)
SUBTOTAL FOR TOTAL SYSTEM CAPITAL INVESTMENT = $\$1097.174 \times 10^6$
(EXCLUDING BUILDING & SUPPORT)

THE BDM CORPORATION

SYSTEM COST DATA (CONTINUED)

RESULTS:

TOTAL DIRECT COST = $\$1097.174 \times 10^6 \times .74$
= $\$811.909 \times 10^6$ (JANUARY '80 DOLLARS)
TOTAL SYSTEM COST = $\$39.784 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
BGC-LURGI PROCESS, SYSTEM NO. 19, BUILDING & SUPPORT FACILITIES

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>GENERAL FACILITIES</u>
TOTAL DIRECT PLUS INDIRECT COSTS SUBTOTAL:	\$ 39.784
TOTAL PROCESS CONTINGENCY SUBTOTAL:	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	<u>\$ 39.784</u>

THE BDM CORPORATION

b. BGC-Lurgi "Instant Plant" Capital Costs

FACILITY INVESTMENT AGGREGATION TABLE
BGC-LURGI PROCESS
(IN MILLIONS OF 1980 DOLLARS)

ITEM DESCRIPTION	SYSTEM NO.	MODULE 1	MODULE 2	MODULE 3	MODULE 4	GENERAL FACILITIES	TOTAL
SYSTEM CAPITAL INVESTMENT							
COAL PREPARATION & FEEDING	1						
GASIFICATION	2	36.53	36.53	36.53	36.53		146.12
INITIAL GAS CLEANUP & COOLING	3	4.3	4.3	4.3	4.3		17.20
ACID GAS REMOVAL	4	24.00	24.00	24.00	24.00		96.00
SULFUR RECOVERY & TAILGAS TREATMENT	5	27.69	13.85	13.85	13.85		69.24
AIR SEPARATION	6	69.50	34.75	34.75	34.75		173.75
COMPRESSION	7	1.39	1.39	1.39	1.39		5.56
PROCESS SOLIDS TREATMENT(DEWATERING)	8	.36	.36	.36	.36		1.440
INCINERATION	9	-0-	-0-	-0-	-0-		-0-
INSTRUMENTATION & CONTROL	10	4.67	4.67	4.67	4.67		18.68
COAL HANDLING	11					74.36	74.36
SOLID WASTE RECYCLING/DISPOSAL	12	21.49	21.49	21.49	21.49		85.96
BYPRODUCTS PROCESSING	13	1.00	1.00	1.00	1.00		4.00
PLANT POWER SYSTEM	14	25.326	25.326	25.326	25.326		101.304
STEAM GENERATION/DISTRIBUTION	15	31.01	31.01	31.01	31.01		124.04
WATER SUPPLY	16	5.56	5.56	5.56	5.56		22.24
COOLING WATER SYSTEM	17	5.02	5.02	5.02	5.02		20.08
WASTE WATER TREATMENT	18	34.30	34.30	34.30	34.30		137.20
GENERAL FACILITIES (BLDG & SUPPORT)	19					39.784	39.784
SUBTOTAL (LESS BLDG & SUPPORT)		292.146	243.556	243.556	243.566	114.144	1097.174
(1) TOTAL SYSTEM CAPITAL INVESTMENT*		43.822	36.533	36.533	36.533	17.122	1136.958
(2) PROJECT CONTINGENCY 15 %							170.543
[15% OF (1)]							
(3) CONTRACTOR'S FEE 4 %		13.439	11.204	11.204	11.204	5.251	52.302
[4% OF (1) + (2)]							
(4) OWNER'S CGSTS 2 %		6.988	5.826	5.826	5.826	2.730	27.196
[2% OF (1)+(2)+(3)]							
TOTAL FACILITY INVESTMENT		356.395	297.119	297.119	297.119	139.247	1386.999
[(1)+(2)+(3)+(4)]							
* INCLUDES PROCESS CONTINGENCIES WHICH TOTAL:		9.77	7.96	7.96	7.96	-0-	33.65
TOTAL SYSTEM CAPITAL INVESTMENT LESS CONTINGENCY		282.376	235.596	235.596	235.596	114.144	1103.308

THE BDM CORPORATION

OTHER CAPITALIZED COSTS AND WORKING CAPITAL BGC-LURGI PROCESS (IN MILLIONS OF 1980 DOLLARS)

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4	GENERAL FACILITIES	TOTAL
A. OTHER CAPITALIZED COSTS						
PAID-UP ROYALTIES	1.78	1.218	1.218	1.218	.571	6.005
0.5 % OF TFI	70.782	70.782	70.782	70.782	-0-	283.128
START-UP AND TESTING						
ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION	78.235	66.089	66.089	66.089	28.991	305.493
SUBTOTAL OF OTHER CAPITALIZED COSTS	<u>150.797</u>	<u>138.089</u>	<u>138.089</u>	<u>138.089</u>	<u>29.562</u>	<u>594.626</u>
B. WORKING CAPITAL						
INITIAL CHARGE OF CATALYSTS AND CHEMICALS	.525	.525	.525	.525	-0-	2.1
MATERIALS INVENTORIES	6.313	6.313	6.313	6.313	-0-	25.252
SPARE PARTS INVENTORIES	1.610	1.342	1.342	1.342	.629	6.265
MINIMUM CASH BALANCE	10.575	10.575	10.575	10.575	-0-	42.3
SUBTOTAL WORKING CAPITAL	<u>19.023</u>	<u>18.755</u>	<u>18.755</u>	<u>18.755</u>	<u>.629</u>	<u>75.917</u>

LAND REQUIREMENTS

BGC-LURGI PROCESS

* COSTS OBTAINED FROM MITTELHAUSER TO ESTIMATE TOTAL CAPITAL REQUIREMENT FOR PROCESSING FACILITIES

THE BDM CORPORATION

TOTAL CAPITAL REQUIREMENTS BGC-LURGI PROCESS (IN MILLIONS OF 1980 DOLLARS)					
ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4	GENERAL FACILITIES TOTAL
TOTAL FACILITY INVESTMENT	356.395	297.119	297.119	297.119	139.247
OTHER CAPITALIZED COSTS	150.797	138.089	138.089	138.089	29.562
LAND RELATED COSTS					2.694
SUBTOTAL DEPRECIABLE INVESTMENT	507.192	435.208	435.208	435.208	171.503
WORKING CAPITAL	19.023	18.755	18.755	18.755	.629
LAND					.9
SUBTOTAL NON-DEPRECIABLE INVESTMENT	19.023	18.755	18.755	18.755	1.529
TOTAL CAPITAL REQUIREMENTS	526.215	453.963	453.963	453.963	173.032
					2061.136

THE BDM CORPORATION

c. **BGC-Lurgi Operations and Maintenance Cost**

THE BDM CORPORATION

MODULE

OPERATING REQUIREMENTS FOR EXPECTED OPERATIONS

BGC-LURGI PROCESS

	BASIS	UNITS
Raw Materials		
Coal, Import	TPY @ 100% Operation	\$ 2,777,650 6PY
Coal Fines Export	TPY @ 100% Operation	838,437 TPY
Catalyst and Chemical Makeup	\$/yr @ 100% Operation	\$ 470,340./Yr
Utility Requirements		
Import Power	Kwh/Yr @ 100% Operation	21,275. Kw-Hr/Yr
Water		1,907 GPM
Operating Requirements		
Labor		
Supervisors	mh/Yr	29,952
Operators	mh/Yr	127,920
Supplies	Factored as 15% of operating labor costs	
Maintenance Requirements		
Labor	Factored as 1.6% of total depreciable direct investment	
Supplies	Factored as 2.4% of total depreciable direct investment	
General Plant Staff	Factored as 30% of operating labor and maintenance labor & supervision	
Administration and Plant Overhead	Factored as 5% of operations & maintenance less feedstock and chemicals	
Module Net MBG Yield	@ 100% Operation	33,622,599 MBTU/YR

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THE BDM CORPORATION

ANNUAL MODULE OPERATING COSTS FOR EXPECTED OPERATIONS BGC-LURGI PROCESS MILLIONS OF JAN. '80 DOLLARS

<u>ITEM DESCRIPTION</u>	<u>UNITS</u>	<u>NET REQUIREMENTS</u>	<u>ANNUAL REQUIREMENTS</u>	<u>COST PER UNIT</u>	<u>ANNUAL COST ($\times 10^6$)</u>
FEEDSTOCK: (KENTUCKY #9 SEAM, DEEP MINE)*	MMBTU	167,116 MMBTU/DAY	54,897,606 MMBTU/YEAR	\$1.25/ MMBTU	68.620
CATALYST & CHEMICAL MAKE-UP					\$0.423
SUBTOTAL FEED & CHEM					<u>69.043</u>
ELECTRIC POWER	KWH	21,295 KW	1.68×10^8 KWH/YEAR	\$.027/ KWH	\$ 4.530
WATER	KGAL	2,746,089 GAL/DAY	902,080,000 GAL/YEAR	\$0.8/ KGAL	\$.720
OPERATING LABOR	(1.6% OF 1/4 OF TFI)				\$ 5.546
OPERATING SUPPLIES	(15% OF O.L.)				\$.225
MAINTENANCE LABOR	(1.6% OF 1/4 OF TFI)				\$ 5.548
MAINTENANCE SUPPLIES	(2.4% OF 1/4 OF TFI)				\$ 8.322
SUPERVISION		29952 HRS	29952 HRS	\$18.83/ HR	\$.560
GENERAL PLANT STAFF	(30% OF O.L. AND M.L. AND SUP)				\$ 2.282
ADMINISTRATION AND GENERAL OVERHEAD	(5% OF O&M LESS FEEDSTOCK AND CHEM.)				\$ 1.184
PROPERTY TAXES AND INSURANCE					-0-
GROSS ANNUAL OPERATING & MAINTENANCE COSTS					\$24.871
BYPRODUCTS CREDITS	MMBTU	50,444 MMBTU/DAY	1.657×10^7 MMBTU/YEAR	\$1/ MMBTU	\$16.570
NET ANNUAL OPERATING & MAINTENANCE COSTS					<u>\$ 8.301</u>
TOTAL					\$77.344

* MEAN BTU VALUE OF FEEDSTOCK = 10,980 BTU/LB.

THE BDM CORPORATION

d. BGC-Lurgi Present Value of Costs, Product Prices, and Cash Flow

THE BDM CORPORATION

PRESENT VALUE OF CAPITAL AND OPERATING AND MAINTENANCE COSTS

MRC-LUPRI

MILLIONS OF DOLLARS

ITEM DESCRIPTION	GENERAL FACILITY	MODULE 1	MODULE 2	MODULE 3	MODULE 4	TOTAL FACILITY
OPERATING AND MAINTENANCE EXPENSES						
FEEDSTOCK	0.00	756.35	727.03	712.46	698.31	2894.15
CATALYST + CHEMICALS	0.00	4.67	1.48	4.30	4.31	17.85
SUBTOTAL	0.00	761.02	731.52	716.86	702.62	2912.00
ELECTRIC POWER	0.00	44.70	42.49	41.94	41.06	170.78
WATER	0.00	2.89	2.58	2.44	2.31	10.23
OPERATING LABOR	0.00	15.97	15.33	15.02	14.72	61.04
OPERATING SUPPLIES	0.00	2.30	2.30	2.25	2.21	9.16
MAINTENANCE LABOR	0.00	58.47	56.10	54.99	53.89	223.49
MAINTENANCE SUPPLIES	0.00	47.71	44.21	42.49	40.83	175.23
SUPERVISION	0.00	5.79	5.56	5.45	5.34	22.13
GENERAL PLANT	0.00	23.61	22.64	22.22	21.77	90.27
ADMIN. + GENERAL	0.00	12.20	11.72	11.48	11.25	46.66
PROPERTY TAXES + INS	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL	0.00	253.93	243.42	234.27	233.37	965.00
SUBTOTAL O&M COSTS	0.00	832.31	799.37	783.08	767.36	3182.12
HYPERDUCT REV	0.00	182.64	175.56	172.05	168.63	698.88
CAPITAL COSTS						
DEPRECIABLE INVESTMENT COST	147.91	443.82	373.51	370.44	364.35	1700.03
NON-DEPRECIABLE INVESTMENT COST	1.32	15.07	14.55	13.93	14.03	58.92
SUBTOTAL CAPITAL COSTS	149.23	458.89	388.06	384.37	378.38	1758.94
TOTAL PRESENT VALUE OF CAPITAL AND OPERATIONS AND MAINTENANCE COSTS	149.23	1291.22	1187.43	1167.45	1145.74	4941.06
ANNUAL PRODUCT (MMBtu)	30260339, 30260339, 30260339, 30260339,					
PRODUCT PRICE (JANUARY 1980 DOLLARS)	\$ 4.31					
PRODUCT PRICE (CURRENT DOLLARS)	\$ 11.54					

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THE BDM CORPORATION

BGC LURGI PROCESS FISCAL YEAR CASH FLOW SUMMARY CONSTANT 1980 DOLLAR PRICE SCHEME

FISCAL YEAR	CAPITAL INVESTMENT	O&M	CAPITAL RECOVERY	TOTAL COSTS	REVENUE	CASH FLOW
1980	11.06	0.00	0.00	11.06	0.00	-11.06
1981	45.33	0.00	0.00	45.33	0.00	-45.33
1982	178.41	0.00	0.00	178.41	0.00	-178.41
1983	431.26	0.00	0.00	431.26	0.00	-431.26
1984	628.06	0.00	0.00	628.06	0.00	-628.06
1985	596.57	42.07	45.16	683.80	65.19	-618.61
1986	394.47	128.00	114.59	637.06	195.56	-441.50
1987	119.70	300.64	225.27	645.61	456.31	-189.30
1988	0.00	345.77	239.35	585.12	521.49	-63.63
1989	0.00	348.02	223.66	571.68	521.49	-50.19
1990	0.00	350.44	208.99	559.43	521.49	-37.94
1991	0.00	353.16	195.35	548.51	521.49	-27.02
1992	0.00	355.91	182.54	538.45	521.49	-16.96
1993	0.00	358.69	170.58	529.27	521.49	-7.78
1994	0.00	361.49	159.43	520.94	521.49	0.55
1995	0.00	364.33	149.03	513.36	521.49	8.13
1996	0.00	367.20	139.26	506.46	521.49	15.03
1997	0.00	367.69	130.16	497.85	521.49	23.64
1998	0.00	368.19	121.63	489.82	521.49	31.67
1999	0.00	368.69	113.68	482.37	521.49	39.12
2000	0.00	369.21	106.26	475.47	521.49	46.02
2001	0.00	369.72	99.31	469.03	521.49	52.46
2002	0.00	370.25	92.79	463.04	521.49	58.45
2003	0.00	370.78	86.74	457.52	521.49	63.99
2004	0.00	371.32	81.06	452.38	521.49	69.11
2005	0.00	325.37	64.08	389.45	456.31	66.86
2006	0.00	232.75	41.18	273.93	325.93	52.00
2007	0.00	46.62	7.96	54.58	65.19	10.61

ALL FIGURES IN MILLIONS OF FISCAL 1980 DOLLARS

THE BDM CORPORATION

5. Lurgi MBG

THE BDM CORPORATION

a. Lurgi System Costs

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THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS LURGI PROCESS, SYSTEM NO. 1, COAL PREPARATION AND FEED

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE</u> 1	<u>MODULE</u> 2	<u>MODULE</u> 3	<u>MODULE</u> 4
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$1	\$1	\$1	\$1
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$1	\$1	\$1	\$1

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI

SYSTEM: 2-GASIFICATION

UNIT OPERATION NUMBER: 20

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: EPRI AF-244 CASE MA

REFERENCE SYSTEM COST: "GASIFICATION & ASH HANDLING"
\$66.21 x 10⁶ (MID '75 DOLLARS)
(INSTALLED COST)

REFERENCE CAPACITY: 16 OPERATING + 2 SPARE; ASH CAPACITY =
1000 TONS/DAY

TVA CAPACITY: 6 OPERATING + 1 SPARE; ASH CAPACITY =
745.6 TONS/DAY

RECOMMENDED CAPACITY EXPONENT: (SEE BELOW)
(1) GASIFIERS = $\left(\frac{7}{18}\right)^1$
(2) ASH HANDLING = 0.6

EXPLANATORY COMMENTS:

REFERENCE COSTS COMBINE GASIFICATION AND ASH HANDLING. REFERENCE COSTS ARE SPLIT BY % COSTS AND SCALED USING SEPARATE CAPACITY FACTORS.

COMPUTATION METHOD:

$$\text{TOTAL SYSTEMS COST} = \left[0.7837 \times \text{REFERENCE COST} \times \frac{7}{18} \right] + \left[0.2163 \times \text{REFERENCE COST} \times \left(\frac{745.6}{1,000} \right)^{0.6} \right]$$

INPUTS:

REFERENCE COST: \$66.21 x 10⁶ (MID-75 DOLLARS) (INSTALLED COST)
% COST OF GASIFIER = 78.37%
% COST OF ASH HANDLING = 21.63%
ESCALATION FACTOR: 1.37 (MID-75 TO JANUARY 80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA (CONTINUED)

RESULTS:

$$\begin{aligned}\text{TOTAL SYSTEMS COST} &= \$20.17 \times 10^6 + \$12.01 \times 10^6 \\ &= \$32.19 \times 10^6 \text{ (MID-75 DOLLARS)} \\ \text{TOTAL SYSTEMS COST} &= \$44.08 \times 10^6 \text{ (JANUARY '80 DOLLARS)}\end{aligned}$$

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

LURGI PROCESS, SYSTEM NO. 2, GASIFICATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 44.08	\$ 44.08	\$ 44.08	\$ 44.08
TOTAL PROCESS CONTINGENCY: 15%				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 6.61	\$ 6.61	\$ 6.61	\$ 6.61
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 50.69	\$ 50.69	\$ 50.69	\$ 50.69

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: 3-GAS COOLING
UNIT OPERATION NUMBER: 21
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: EPRI AF-642 CASE MXSC
REFERENCE SYSTEM COST: $\$8.94 \times 10^6$ (MID-76 DOLLARS)
REFERENCE CAPACITY: 109.8×10^6 BTU/HR
TVA CAPACITY: 458.3×10^6 BTU/HR
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

$$\text{TVA COST} = 2 \times \frac{\text{EPRI}}{3} \times \left(\frac{\text{TVA BTU/HR}}{\text{EPRI BTU/HR}} \right)^{0.6}$$

INPUTS:

REFERENCE COST = $\$8.94 \times 10^6$ (MID-76 DOLLARS)

CAPACITY FACTOR = $2/3 \times (458.3/109.8)^{0.6} = 1.57$

ESCALATION FACTOR FOR JANUARY '80 DOLLARS = 1.30

RESULTS:

TVA COST = $\$8.94 \times 10^6 \times 1.57 = 14.04 \times 10^6$ (MID-76 DOLLARS)

TVA COST IN JANUARY '80 DOLLARS = $\$18.25 \times 10^6$

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

LURGI PROCESS, SYSTEM NO. 3, INITIAL GAS CLEAN-UP AND COOLING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 18.25	\$ 18.25	\$ 18.25	\$ 18.25
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	-0-	-0-	-0-	-0-
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 18.25	\$ 18.25	\$ 18.25	\$ 18.25

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: 4-ACID GAS REMOVAL (SELEXOL)
UNIT OPERATION NUMBER: 22
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: EPRI AF-916 CASE 4B
REFERENCE SYSTEM COST: N/A
REFERENCE CAPACITY: 407,775 ACFH
TVA CAPACITY: 481,686 ACFH
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

$$\text{TVA COST} = \frac{\text{EPRI COST}}{3} \times \left(\frac{\text{TVA ACFH}}{\text{EPRI ACFH}} \right)^{0.6}$$

INPUTS:

REFERENCE COST = \$54,227,000 (MID-1976 DOLLARS)

ESTIMATED REFERENCE COST OF ONE TRAIN = \$18,075,666

CAPACITY FACTOR = $(481,686/407,775)^{0.6} = 1.1$

ESCALATION FACTOR FOR JANUARY '80 DOLLARS = 1.30

TOTAL SYSTEM COST = $\$18.076 \times 10^6 \times 1.1 = \19.884 (MID-'76 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$25.847 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS LURGI PROCESS, SYSTEM NO. 4, ACID GAS REMOVAL (SELEXOL)

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 25.85	\$ 25.85	\$ 25.85	\$ 25.85
TOTAL PROCESS CONTINGENCY: 5%				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 1.29	\$ 1.29	\$ 1.29	\$ 1.29
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 27.14	\$ 27.14	\$ 27.14	\$ 27.14

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: 5-SULFUR RECOVERY & TAIL GAS TREATING
UNIT OPERATION NUMBER: 36
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: DOE REPORT FE-1775-18, PLANT 2
REFERENCE SYSTEM COST: \$9,032,000 (MID '77\$)
REFERENCE CAPACITY: 181.2 LT/D SULFUR PRODUCT
TVA CAPACITY: 158.1 LT/D SULFUR PRODUCT
RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

1. PROCESS NOTE: NOMINAL OPERATING RATE FOR PLANT 2 IS 240 M/H FEED ALTHOUGH DESIGN IS 527.5 M/H.
2. PROVIDE 2 TRAINS FOR MODULE, 1 OPERATING PLUS 1 SPARE, AND 1 TRAIN FOR EACH ADDITIONAL MODULE.

COMPUTATION METHOD:

$$\text{TOTAL SYSTEM COST} = \text{REFERENCE COST} \times \text{NO. OF TRAINS} \\ \times \text{INDIRECT FACTOR} \times \left(\frac{\text{TVA CAP}}{\text{REF CAP}} \right)^{0.6}$$

INPUTS:

REFERENCE COST = \$9,032,000 (MID-1977 DOLLARS)

ADJUSTMENT TO INCLUDE INDIRECT CONSTRUCTION ENGINEERING/HOME OFFICE COSTS = 1.10

ADJUSTED REFERENCE COST = \$9,935,200

CAPACITY FACTOR = $(158.1/181.2)^{0.6} = .92$

NUMBER OF TRAINS (MODULE 1) = 2

NUMBER OF TRAINS (MODULES 2, 3, 4) = 1

ESCALATION FACTOR = 1.22 (1977 TO 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA (CONTINUED)

RESULTS:

TOTAL SYSTEM COST = $\$9,935,200 \times .92 \times 2$ TRAINS FOR MODULE 1 =
\$18,280,768 (MID-'77 DOLLARS FOR MODULE I)

TOTAL SYSTEM COST FOR MODULE I = $\$22.30 \times 10^6$ (JANUARY '80 DOLLARS)

TOTAL SYSTEM COST FOR MODULES II, III, AND IV = $\$11.15 \times 10^6$
(JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

LURGI PROCESS, SYSTEM NO. 5, SULFUR RECOVERY AND TAIL GAS TREATING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
<u>SUBTOTAL:</u>	\$ 22.30	\$ 11.15	\$ 11.15
TOTAL PROCESS CONTINGENCY: 15%			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
SUBSYSTEM NO. _____			
<u>SUBTOTAL:</u>	\$ 3.35	\$ 1.67	\$ 1.67
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 25.65	\$ 12.82	\$ 12.82

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: G-AIR SEPARATION
UNIT OPERATION NUMBER: 80
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: MITTELHAUSER COST CURVES (ENCLOSED)
REFERENCE SYSTEM COST: $\$35.0 \times 10^6$ EACH (5 REQUIRED)
REFERENCE CAPACITY: N/A
TVA CAPACITY: $5 \times 1,680$ TPD @ 514.7 PSI O_2
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:

2 INSTALLED WITH FIRST MODULE AND 1 WITH EACH ADDITIONAL MODULE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = NO. OF UNITS \times REFERENCE SYSTEM COST

INPUTS:

NO. OF UNITS = 2 ~ MODULE 1
 = 1 ~ MODULES 2-4
 5 TOTAL

REFERENCE SYSTEM COST = $\$35.0 \times 10^6$ (JANUARY '80 DOLLARS)

RESULTS:

TOTAL MODULE 1 COST = $\$70 \times 10^6$

TOTAL MODULE 2-4 COST = $\$35 \times 10^6$ (FOR EACH MODULE)

TOTAL FACILITY COST = $\$175 \times 10^6$ (JANUARY '80 DOLLARS)

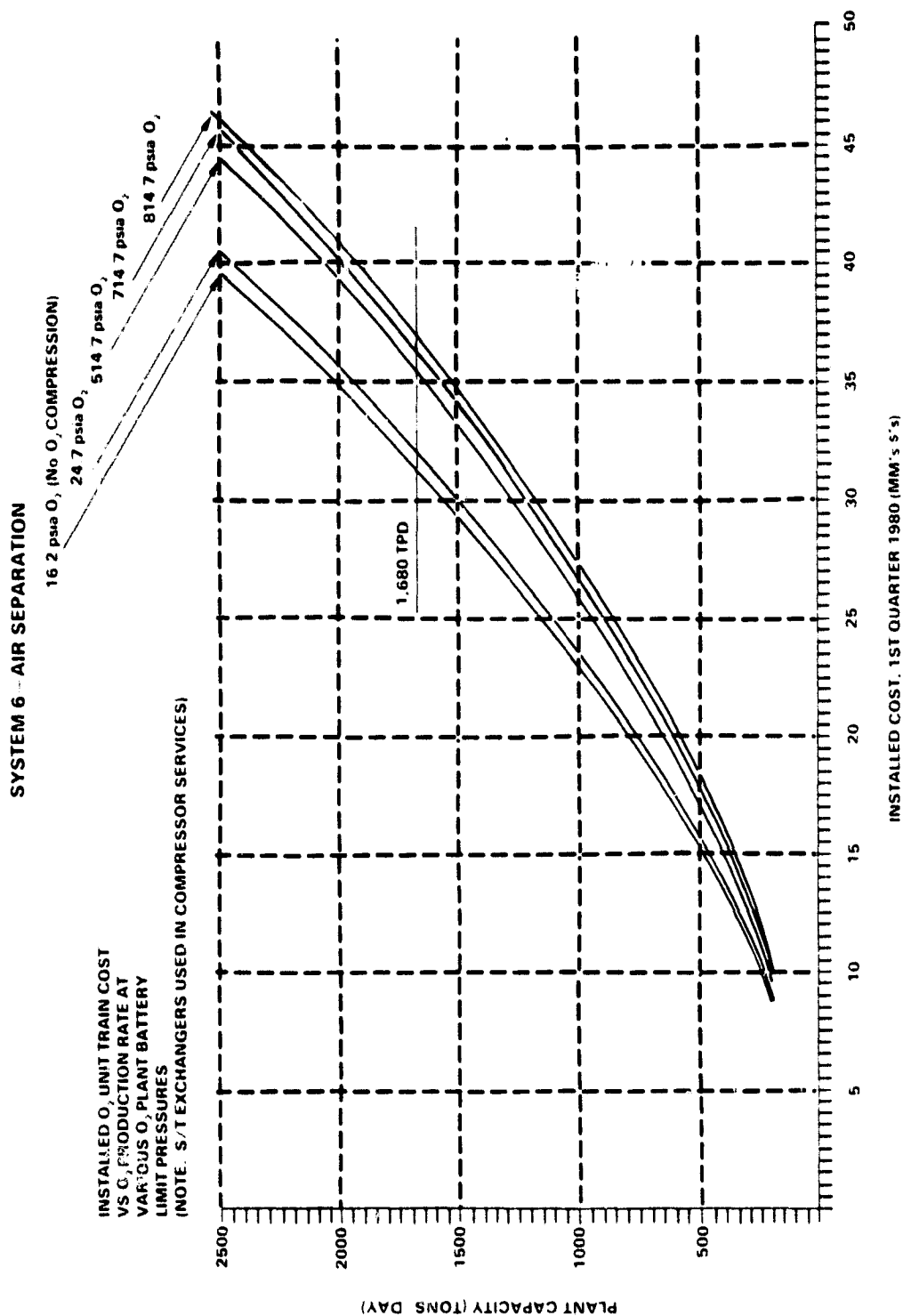


Figure III-1. System 6 -- Air Separation System Cost Curves

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

LURGI PROCESS, SYSTEM NO. 6, AIR SEPARATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 70.0	\$ 35.0	\$ 35.0	\$ 35.0
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 70.0	\$ 35.0	\$ 35.0	\$ 35.0

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: 7-COMPRESSION
UNIT OPERATION NUMBER: 23
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: GUTHRIE p. 167
MODULAR FACTOR = 2.21
REFERENCE SYSTEM COST: N/A
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = EQUIPMENT COST x MODULAR FACTOR.

INPUTS:

EQUIPMENT COST = \$690,770 (JANUARY '80 DOLLARS)
MODULAR FACTOR = 2.21

RESULTS:

TOTAL SYSTEM COST = $\$1.53 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

LURGI PROCESS, SYSTEM NO. 7, COMPRESSION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 1.53	\$ 1.53	\$ 1.53	\$ 1.53
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 1.53	\$ 1.53	\$ 1.53	\$ 1.53

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: 8-PROCESS SOLIDS TREATMENT
UNIT OPERATION NUMBER: 31
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST ESTIMATE
REFERENCE SYSTEM COST: \$265,000 DIRECT COST ESTIMATE
(JANUARY '80 DOLLARS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SYSTEMS COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

LIME DEWATERING PONDS	\$ 75,000
CONVEYOR	190,000
TOTAL DIRECT COST	<u>\$265,000</u>
INCLUDES ALL PUMPS, INSTRUMENTS	

INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = \$360,400 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

LURGI PROCESS, SYSTEM NO. 8, PROCESS SOLIDS TREATMENT

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$.36	\$.36	\$.36	\$.36
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$.36	\$.36	\$.36	\$.36

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI

SYSTEM: 10-INSTRUMENTATION AND CONTROL

UNIT OPERATION NUMBER: N/A

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: VENDOR ESTIMATE FROM GENERAL ELECTRIC

REFERENCE SYSTEM COST: \$1.5 MILLION FOR A SYSTEM WITH CAPACITY SUFFICIENT FOR TVA NEEDS. IT IS BASED UPON A HONEYWELL 4500 SYSTEM.

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THE SYSTEM CONTAINS JUST THE NECESSARY MATERIAL FOR THE CENTRALIZED OF REMOTE FACILITY. IT CONTAINS SUFFICIENT CABLE TO TRANSMIT SIGNALS FROM THE PROCESS UNITS; DATA PROCESSING EQUIPMENT, SOFTWARE PACKAGES FOR THE ANALYSIS OF INCOMING DATA, AND DISPLAY PANELS FOR PRESENTATION OF DATA. THIS SYSTEM DOES NOT INCLUDE LOCAL CONTROLS FOR DIRECT OPERATION OF INDIVIDUAL SYSTEMS.

COMPUTATION METHOD:

TOTAL DIRECT COST = $(1 + \text{INSTALLATION FACTOR}) \times \text{REFERENCE COST}$
TOTAL SYSTEM COST = $(1 + \text{INDIRECT COST FACTOR}) \times \text{TOTAL DIRECT COST}$

INPUTS:

FIELD INSTALLATION FACTOR = 1.10 (ASSUMED)

TOTAL DIRECT COSTS = $\$3.15 \times 10^6$ (JANUARY '80 DOLLARS)

INDIRECT COST FACTOR = 0.289 (90/10 ASSUMED M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = $\$4.060 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS LURGI PROCESS, SYSTEM NO. 10, INSTRUMENTATION AND CONTROL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 4.06	\$ 4.06	\$ 4.06	\$ 4.06
TOTAL PROCESS CONTINGENCY:				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 0.609	\$ 0.609	\$ 0.609	\$ 0.609
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 4.669	\$ 4.669	\$ 4.669	\$ 4.669

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI

SYSTEM: 11-COAL HANDLING

UNIT OPERATION NUMBER: 10

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: RESOURCE ENGINEERING, INC. ESTIMATE BASED ON IN-HOUSE COST DATA. SEE DETAILED EQUIPMENT LISTING WHICH FOLLOWS.

REFERENCE SYSTEM COST: 48.1×10^6 (JANUARY '80 DOLLARS) (TOTAL DIRECT COST)

REFERENCE CAPACITY: 20,000 TPD

TVA CAPACITY: 30,440 TPD

RECOMMENDED CAPACITY EXPONENT: 0.35

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)
TOTAL DIRECT COST (E+M+L) = REFERENCE COST \times CAPACITY FACTOR

$$\text{CAPACITY FACTOR} = \left(\frac{\text{TVA CAPACITY}}{\text{REFERENCE CAPACITY}} \right)^{0.35}$$

INPUTS:

REFERENCE SYSTEM COST = 48.1×10^6 (JANUARY '80 DOLLARS)

INDIRECT COST FACTOR = 0.335 (80/20 ASSUMED M/L RATIO FOR SOLIDS HANDLING)

$$\text{CAPACITY FACTOR} = \left(\frac{30,440}{20,000} \right)^{0.35} = 1.158$$

RESULTS:

TOTAL DIRECT COST = 55.699×10^6

TOTAL SYSTEM COST = 74.36×10^6 (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM 11

COAL HANDLING

(EQUIPMENT FACTORED COSTS)

<u>DESCRIPTION</u>	<u>JAN '80 \$ x (10⁶)</u>
1. Continuous barge unloader, elevator type, 3,000-3,500 TPH, including dock, moorings, surge bin, conveyors	\$ 10.0
2. Open coal storage piles, 1.8 x 10 ⁵ tons Double windows 100' high x (2 x 240') wide x 2,800' Costs for site preparation, stockpiling conveyors, stacker/reclaiming equipment, mobile equipment	30.0
3. Rotary brakers, three (2N, 1S), 1,000 TPH each 50 hp each, 12' ϕ x 22' each	1.0
4. Concrete silos, four, 11,750 tons each, 67' ϕ x 150' each	6.0
5. Truck dump hopper, 2,000 tons	0.2
6. Conveyors not included above	0.3
a. Truck station to crusher, 500 TPH 36" x 500 ft., 0 elevation, 426 fpm, 32 hp	
b. Crusher to silos, 2,160 TPH 60" x 700 ft., 150 ft. elevation, 470 hp, 600 fpm	<u>0.6</u>
TOTAL DIRECT COSTS (E+M+L) =	\$ 48.1

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
LURGI PROCESS, SYSTEM NO. 11, COAL HANDLING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>OFFSITE FACILITIES</u>
TOTAL DIRECT PLUS INDIRECT COSTS SUBTOTAL:	\$ 74.36
TOTAL PROCESS CONTINGENCY SUBTOTAL:	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	<u>\$ 74.36</u>

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI

SYSTEM: 12-SOLIDS WASTE RECYCLING/DISPOSAL

UNIT OPERATION NUMBER: 81

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATE (FROM IN-HOUSE COST DATA BASE)

REFERENCE SYSTEM COST: $\$16.1 \times 10^6$ (JANUARY '80 DOLLARS) (TOTAL DIRECT COSTS)

NOTE: INSTALLED COST OF SOLIDS DISPOSAL AREA; $\$10.0 \times 10^6$
INSTALLED COST OF RUN OFF COLLECTION BASIN: $\underline{6.1 \times 10^6}$
 $\$16.1 \times 10^6$

REFERENCE CAPACITY: N/A

TVA CAPACITY: 61,000 #/HR SOLIDS (DRY), 2319 GAL/HR
H₂O W/SOLIDS

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. SYSTEM IS ESSENTIALLY AN EXCAVATED 20 YEARS AREA FOR SOLID DISPOSAL. INCLUDES EXCAVATION & CONSTRUCT OF CLAY LINED DISPOSAL AREA.
2. LAND COSTS ARE NOT INCLUDED

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

INDIRECT COST FACTOR = 0.335 (80/20 ASSUMED M/L RATIO FOR SOLIDS HANDLING)

TOTAL DIRECT COST = $\$16.1 \times 10^6$

RESULTS:

TOTAL SYSTEM COST = $\$21.494 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

LURGI PROCESS, SYSTEM NO. 12, SOLIDS WASTE RECYCLING/DISPOSAL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. LINED DISPOSAL AREA	\$ 13.350	\$ 13.350	\$ 13.350	\$ 13.350
SUBSYSTEM NO. RUN OFF COLLECTION	\$ 8.144	\$ 8.144	\$ 8.144	\$ 8.144
<u>SUBTOTAL:</u>	\$ 21.494	\$ 21.494	\$ 21.494	\$ 21.494
TOTAL PROCESS CONTINGENCY SUBTOTAL:	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 21.494	\$ 21.494	\$ 21.494	\$ 21.494

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	LURGI
<u>SYSTEM:</u>	13-BYPRODUCTS PROCESSING
<u>UNIT OPERATION NUMBER:</u>	83-SULFUR STORAGE & LOADING
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	MITTELHAUSER (IN-HOUSE COST DATA BASE)
<u>REFERENCE SYSTEM COST:</u>	$\$1 \times 10^6$ (JANUARY '80 DOLLARS)
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	

TOTAL SYSTEM COST = $\$1 \times 10^6$ (JANUARY '80 DOLLARS) FOR EACH MODULE

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS LURGI PROCESS, SYSTEM NO. 13, BYPRODUCTS PROCESSING

SYSTEM CAPITAL INVESTMENT TABLE

ITEM DESCRIPTION	MODULE 1	MODULE 2	MODULE 3	MODULE 4
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 1	\$ 1	\$ 1	\$ 1
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	-0-	-0-	-0-	-0-
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 1	\$ 1	\$ 1	\$ 1

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI

SYSTEM: 14-PLANT POWER SYSTEM

UNIT OPERATION NUMBER: 87

SUBSYSTEM: POWER GENERATION

REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA, FROM PROCESS
PLANT AND CONTROL

REFERENCE SYSTEM COST: $\$10 \times 10^6$ MID-1978 (REFER TO FOLLOWING
PAGE) (DIRECT + INDIRECT COST)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 14,100 KW FOR SINGLE MODULE

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST \times ESCALATION FACTOR

INPUTS:

ESCALATION FACTOR = 1.14
REFERENCE SYSTEM COST = $\$10 \times 10^6$ (MID-1978)

RESULTS:

TOTAL SYSTEM COST = $\$11.4 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM 14 PLANT POWER

POWER GENERATED

$$\begin{array}{rclclcl} 650 \text{ PSIG, } 750^{\circ}\text{F} \rightarrow 150 \text{ PSIG} & = & 9.0 \text{ MW} & = & 12,100 \text{ HP} \\ 50 \text{ PSIG, SAT.} \rightarrow \text{COND.} & = & 5.1 \text{ MW} & = & 6,800 \text{ HP} \\ & & \underline{14.1 \text{ MW}} & = & \underline{18,900 \text{ HP}} \end{array}$$

$$14,100 \text{ KW TURBOGENERATOR} = 5.5 \times 10^6 \times (1.88) = \$10.3 \times 10^6 \text{ (MID-'78)} \\ \text{(INCLUDES STEAM GENERATING FACILITY)}$$

BACKOUT BOILER SAY GENERATING 650 PSIG, 750°F STEAM
STM TURBINE $\eta = 79\%$, GENERATOR $\eta = 95\%$

$$\text{STM RATE} = 7.201 \text{ LB/KWHR}$$

$$m = \frac{14,100}{.79(.95)} \times 7.201 = 135,290 \text{ LB/HR}$$

$$\begin{aligned} \text{BASE COST} &= \$800,000 \text{ MID-1970} \\ &= \$1,392,000 \text{ MID-1978 @ 250 PSIG, } 100^{\circ}\text{F SH} \\ &= \$2,859,000 \text{ MID-1978 @ 650 PSIG, } 750^{\circ}\text{F} \\ &= \$5,106,000 \text{ MID-1978 TOTAL MODULE} \end{aligned}$$

14,100 KW TURBOGENERATOR

$$\text{TVA} = 10.3 \times (1.462) - 5.1 = \$10 \times 10^6 \text{ MID-1978}$$

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: 14-PLANT POWER
UNIT OPERATION NUMBER: 87
SUBSYSTEM: PLANT DISTRIBUTION
REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA
REFERENCE SYSTEM COST: \$102.62 (1970 DOLLARS/KILOWATT)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 16264.078 KW
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS PROCESS DOES NOT INCLUDE ANY POWER GENERATING CAPACITY. SYSTEM COSTS REPRESENT ONLY POWER DISTRIBUTION NEEDS.

COMPUTATION METHOD:

SYSTEM COST = KILOWATT REQUIREMENT x TOTAL DIRECT COST FACTOR
(1 + INDIRECT COST FACTOR) x ESCALATION FACTOR

INPUTS:

KILOWATT REQUIREMENT = 16264.078 KW
TOTAL DIRECT COST FACTOR = \$102.62 (1970 DOLLARS/PER KILOWATT)
INDIRECT COST FACTOR = 0.469 (BASED UPON 0.72 L/M RATIO)
ESCALATION FACTOR = 1.988 (FROM 1970 TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$4.874 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS LURGI PROCESS, SYSTEM NO. 14, PLANT POWER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. PLANT POWER	\$ 11.4	\$ 11.4	\$ 11.4	\$ 11.4
SUBSYSTEM NO. PLANT DISTRIBUTION	\$ 4.874	\$ 4.874	\$ 4.874	\$ 4.874
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 16.274	\$ 16.274	\$ 16.274	\$ 16.274
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	-0-	-0-	-0-	-0-
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 16.274	\$ 16.274	\$ 16.274	\$ 16.274

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: 15-STEAM GENERATION, DISTRIBUTION
UNIT OPERATION NUMBER: 86
SUBSYSTEM: FLUE GAS TREATMENT
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST ESTIMATE
REFERENCE SYSTEM COST: $\$15.9 \times 10^6$ (NOVEMBER 1977)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST \times (1 + INDIRECT COST FACTOR) \times ESCALATION FACTOR

INPUTS:

REFERENCE SYSTEM COST = $\$15.9 \times 10^6$ (NOVEMBER 1977)
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)
ESCALATION FACTOR = 1.14 (FROM NOVEMBER 1977 TO JANUARY '80 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$24.65 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: 15-STEAM GENERATION & DISTRIBUTION
UNIT OPERATION NUMBER: 84 - STEAM & CONDENSATE
SUBSYSTEM: COAL-FIRED BOILER & ESP
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST ESTIMATE
REFERENCE SYSTEM COST: 2 BOILERS @ $\$7.2 \times 10^6$ (MID 78 DOLLARS)
(DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST \times (1 + INDIRECT COST
FACTOR) \times ESCALATION FACTOR

INPUTS:

REFERENCE SYSTEM COST = $\$14.4 \times 10^6$ DIRECT COSTS (MID 78 DOLLARS)
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)
ESCALATION FACTOR = 1.14 (MID 78 TO JANUARY '80 DOLLARS)

RESULTS:

TOTAL INSTALLED COST = $\$19.58 \times 10^6$ (MID '78 DOLLARS)
TOTAL SYSTEM COST = $\$22.32 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI

SYSTEM: 15-STEAM GENERATION/DISTRIBUTION

UNIT OPERATION NUMBER: 84

SUBSYSTEM: PLANT DISTRIBUTION

REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA
PROCESS PLANT ESTIMATED EVALUATION AND
CONTROL, p. 365

REFERENCE SYSTEM COST: TOTAL DIRECT COST FACTOR = 1.68 (1970
DOLLARS PER LBS/HR)

REFERENCE CAPACITY: N/A

TVA CAPACITY: STEAM REQUIREMENT = 1×10^6 LBS/HR

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

SYSTEM DESIGN DOES NOT REQUIRE ANY INDEPENDENT STEAM GENERATION
BOILERS. SYSTEM COSTS REPRESENT DISTRIBUTION REQUIREMENTS
INCLUDING PIPING, TRAPS, AND SUPERHEATERS.

COMPUTATION METHOD:

SYSTEM COST = STEAM REQUIREMENT \times TOTAL DIRECT COST FACTOR \times
(1 + INDIRECT COST FACTOR) \times ESCALATION FACTOR

INPUTS:

STEAM REQUIREMENT = 1×10^6 LBS/HR.
TOTAL DIRECT COST FACTOR = 1.68 (1970 DOLLARS PER LBS/HR.)
INDIRECT COST FACTOR = 0.488 (BASED ON AN L/M RATIO OF 0.82)
ESCALATION FACTOR = 1.988 (1970 TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$4.97 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS LURGI PROCESS, SYSTEM NO. 15, STEAM GENERATION/DISTRIBUTION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM: FLUE GAS TREATMENT	\$ 24.65	\$ 24.65	\$ 24.65	\$ 24.65
SUBSYSTEM: STEAM & CONDENSATE	\$ 22.32	\$ 22.32	\$ 22.32	\$ 22.32
SUBSYSTEM: PLANT DISTRIBUTION	\$ 4.97	\$ 4.97	\$ 4.97	\$ 4.97
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	\$ 51.94	\$ 51.94	\$ 51.94	\$ 51.94
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
<u>SUBTOTAL:</u>	-0-	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 51.94	\$ 51.94	\$ 51.94	\$ 51.94

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: 16-WATER SUPPLY
UNIT OPERATION NUMBER: 85
SUBSYSTEM: RAW H₂O CLARIFICATION
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: \$.689 x 10⁶ (JANUARY '80 DOLLARS) (SEE BELOW)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SYSTEM COST = (REFERENCE SYSTEM COST - CONTINGENCY₁) x
(1 + INDIRECT COST FACTOR)
CONTINGENCY = TOTAL SYSTEM COST x CONTINGENCY₂ FACTOR

INPUTS:

REFERENCE SYSTEM COST	
FIRE WATER POND	\$ 192,000
CLARIFIER	380,000
RECARBONATOR	40,000
CONTINGENCY ₁	75,000
	\$ 689,000

(INCLUDES PUMPS, CHEM. FEED, INSTRUMENTS)

CONTINGENCY₂ FACTOR = 10%

INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = \$835,040 (JANUARY '80 DOLLARS)

CONTINGENCY = \$.08 x 10⁶ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: LURGI
SYSTEM: 16-WATER SUPPLY
UNIT OPERATION NUMBER: 85
SUBSYSTEM: DEMINERALIZER
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: $\$6.2 \times 10^6$ (JANUARY '80 DOLLARS) (SEE BELOW)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

$$\begin{aligned} \text{TOTAL SYSTEM COST} &= (\text{REFERENCE SYSTEM COST} - \text{CONTINGENCY}_1) \times \\ &\quad (1 + \text{INDIRECT COST FACTOR}) \\ \text{CONTINGENCY} &= \text{TOTAL SYSTEM COST} \times \text{CONTINGENCY}_2 \text{ FACTOR} \end{aligned}$$

INPUTS:

REFERENCE SYSTEM COST	
SAND FILTERS	\$ 600,000
DEMINERALIZER TRAINS	5,200,000
CHEM STORAGE TANKS	100,000
CONTINGENCY ₁	<u>300,000</u>
	\$ 6,200,000

CONTINGENCY₂ FACTOR = 5%

INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = \$8,024,000 (JANUARY '80 DOLLARS)

CONTINGENCY = $\$.4 \times 10^6$ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

LURGI PROCESS, SYSTEM NO. 16, WATER SUPPLY

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>MODULE 1</u>	<u>MODULE 2</u>	<u>MODULE 3</u>	<u>MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS				
SUBSYSTEM NO. CLARIFICATION	\$.84	\$.84	\$.84	\$.84
SUBSYSTEM NO. DEMINERALIZER	\$ 8.02	\$ 8.02	\$ 8.02	\$ 8.02
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$ 8.86	\$ 8.86	\$ 8.86	\$ 8.86
TOTAL PROCESS CONTINGENCY				
SUBSYSTEM NO. CLARIFICATION (10%)	\$.08	\$.08	\$.08	\$.08
SUBSYSTEM NO. _____				
SUBSYSTEM NO. DEMINERALIZER (5%)	\$.400	\$.400	\$.400	\$.400
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBSYSTEM NO. _____				
SUBTOTAL:	\$.480	\$.480	\$.480	\$.480
TOTAL SYSTEM CAPITAL INVESTMENT:	\$ 9.34	\$ 9.34	\$ 9.34	\$ 9.34

THE BDM CORPORATION

SUBSYSTEM COST DATA

20B - Main Methanation System

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 90-EX-1 and 90-C-1

Category: Turbine Expander and Compressor Subsystem

Number of Units: 2

Design Data:

Size
Duty
Etc. (Temp./Press)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : 2,623,000

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_P
Size	F_{Mag}

Purchased Equipment Cost E [$E = B \times (F_M \times F_T \times F_P \times F_{Mag})$] SE 2,900,000

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

THE JDM CORPORATION

Subtotal Field Materials (M) % x B	.242 of B	\$M	635,000
Total Direct Material (E+M)			<u>\$(E+M) 3,535,000</u>
Labor Component (L) % x B	.292 of B	\$L	<u>765,000</u>
Subtotal Installed Equipment (E+M+L)			\$(E+M+L) 4,300,000
Indirect Construction Costs	.36 of (E+M+L)		<u>1,550,000</u>
			<u>\$5,850,000</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January '80 dollars 1.14

TOTAL MODULE COST, EQUIPMENT

\$6.670 x 10⁶

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPEKS-101ZEK/SNG PROCESS, SYSTEM NO. 20B, ALTERNATE PRODUCTS/MAIN METHANATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 1</u>	<u>SNG MODULE 2</u>
TOTAL DIRECT PLUS INDIRECT COSTS		
SUBSYSTEM NO. HEAT EXCHANGERS	\$ 5.007	\$ 5.007
SUBSYSTEM NO. VESSELS	1.952	1.952
SUBSYSTEM NO. CENTRIFUGAL PUMPS	.041	.041
SUBSYSTEM NO. EXPANDER AND COMPRESSOR	6.670	6.670
<u>SUBTOTAL:</u>	<u>13.670</u>	<u>16.670</u>
TOTAL PROCESS CONTINGENCY: 0%		
<u>SUBTOTAL:</u>	<u>-0-</u>	<u>-0-</u>
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	<u>\$13.670</u>	<u>\$13.670</u>

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 20-C ALTERNATE PRODUCTS/GAS DRYING
UNIT OPERATION NUMBER: 90 - GAS DRYING
REFERENCE SOURCE FOR COSTING: C. F. BRAUN
FE-2240-31
REFERENCE SYSTEM COST: \$.400 x 10⁶ (1977 DOLLARS)
REFERENCE CAPACITY: 15271 LB-MOL/HR GAS FEED
TVA CAPACITY: 6266 LB-MOL/HR GAS FEED
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST x INDIRECT CONSTRUCTION
COSTS x CAPACITY FACTOR x ESCALATION FACTOR

$$\text{CAPACITY FACTOR} = \left(\frac{\text{TVA CAP}}{\text{REF CAP}} \right)^{0.6}$$

INPUT:

REFERENCE SYSTEM COST = \$.400 x 10⁶ (1977 DOLLARS)

INDIRECT CONSTRUCTION COSTS = 1.10
(I.E., ENGINEERING AND
HOME OFFICE)

$$\text{CAPACITY FACTOR} = \left(\frac{6,266}{15,271} \right)^{0.6} = 0.586$$

ESCALATION FACTOR = 1.22 (TO JANUARY '80 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$.3146 x 10⁶ (JANUARY '80 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 20C, ALTERNATE PRODUCTS/GAS DRYING

SUBSYSTEM INVESTMENT/AGGREGATION TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 1</u>	<u>SNG MODULE 2</u>
TOTAL DIRECT PLUS INDIRECT COSTS SUBTOTAL:	\$.315	\$.315
TOTAL PROCESS CONTINGENCY: - 0% SUBTOTAL	- 0 -	- 0 -
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	<u>\$.315</u>	<u>\$.315</u>

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTLK/SNG PROCESS, SYSTEM NO. 20, ALTERNATE PRODUCTS

SYSTEM CAPITAL INVESTMENT TABLE

	SNG MODULE 1	SNG MODULE 2
--	--------------------	--------------------

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS		
SYSTEM SHIFT CONVERSION	\$ 2.943	\$ 2.943
SYSTEM MAIN METHANATION	13.670	13.670
SYSTEM GAS DRYING	.315	.315
SUBTOTAL:	\$16.928	\$16.928

TOTAL PROCESS CONTINGENCY: - 0%

SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$16.928

\$16.928

THE BDM CORPORATION

d. **Koppers - Totzek/SNG "Instant Plant" Capital Costs**

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THE BDM CORPORATION

TOTAL FACILITY INVESTMENT AGGREGATION TABLE
KOPPERS-TOI/ZEK/SNG PROCESS

SYSTEM NO.	SYSTEM NAME	SNG MODULE 1	SNG MODULE 2	MBG MODULE 3	MBG MODULE 4	GENERAL FACILITIES	TOTAL
1	COAL PREPARATION & FEEDING	86.604	86.604	86.604	86.604		346.416
2	GASIFICATION						
3	INITIAL GAS CLEANUP & COOLING						
4	ACID GAS REMOVAL	38.593	38.693	38.693	38.693		154.772
5	SULFUR RECOVERY & TAILGAS TREATMENT	26.373	13.186	13.186	13.186		65.931
6	AIR SEPARATION	74.700	73.600	73.600	73.600		295.500
7	COMPRESSION	22.638	22.638	22.638	22.638		90.552
8	PROCESS SOLIDS TREATMENT(DEWATERING)	.860	.860	.860	.860		3.440
9	INCINERATION	-0-	-0-	-0-	-0-		-0-
10	INSTRUMENTATION & CONTROL	4.669	4.669	4.669	4.669		18.676
11	COAL HANDLING	-0-	-0-	-0-	-0-	64.214	64.214
12	SOLIDS WASTE RECYCLING/DISPOSAL	21.494	21.494	21.494	21.494		85.976
13	BYPRODUCTS PROCESSING	1.000	1.000	1.000	1.000		4.000
14	PLANT POWER SYSTEM	35.347	35.347	35.347	35.347		141.388
15	STEAM GENERATION/DISTRIBUTION	6.833	6.833	3.852	3.852		21.370
16	WATER SUPPLY	5.458	5.458	5.458	5.458		21.832
17	COOLING WATER SYSTEM	6.028	6.028	6.028	6.028		24.112
18	WASTE WATER TREATMENT	.208	.208	.208	.208		.832
19	GENERAL FACILITIES (BLDG & SUPPORT)	-0-	-0-	-0-	-0-	49.464	49.464
20	ALTERNATE PRODUCTS	16.928	16.928	-0-	-0-		33.856
	SUBTOTAL (LESS BLDG & SUPPORT)						1372.867
(1)	TOTAL SYSTEM CAPITAL INVESTMENT	347.833	333.546	313.637	313.637	113.678	1422.331
(2)	PROJECT CONTINGENCY 15 % [15% OF (1)]	52.175	50.032	47.046	47.046	17.052	213.351
(3)	CONTRACTOR'S FEE 4 % [4% OF (1) + (2)]	16.000	15.343	14.427	14.427	5.229	65.426
(4)	OWNER'S COSTS 2 % [2% OF (1)+(2)+(3)]	8.320	7.978	7.502	7.502	2.719	34.821
	TOTAL FACILITY INVESTMENT	424.328	406.899	382.612	382.612	138.678	1735.129

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THE BDM CORPORATION

OTHER CAPITALIZED COSTS AND WORKING CAPITAL KOPPERS-LOTZER/SNG PROCESS

ITEM DESCRIPTION	SNG MODULE 1	SNG MODULE 2	MBG MODULE 3	MBG MODULE 4	GENERAL FACILITIES	TOTAL
A. OTHER CAPITALIZED COSTS						
PAID-UP ROYALTIES 0.5 % OF IFI	2.122	2.034	1.913	1.913	.693	8.675
START-UP AND TESTING	92.128	92.128	84.417	84.417	-0-	353.090
ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION	93.729	90.157	86.436	86.436	28.874	385.632
SUBTOTAL OF OTHER CAPITALIZED COSTS	187.979	184.319	172.766	172.765	29.567	747.397
B. WORKING CAPITAL						
INITIAL CHARGE OF CATALYSTS AND CHEMICALS	6.894	6.894	.600	.600		14.988
MATERIALS INVENTORIES	4.269	4.269	4.141	4.141		16.820
SPARE PARTS INVENTORIES	1.923	1.844	1.734	1.734	.628	7.863
MINIMUM CASH BALANCE	13.768	13.768	12.914	12.914		53.364
SUBTOTAL WORKING CAPITAL	26.854	26.775	19.389	19.389	.628	93.035

THE BDM CORPORATION

LAND REQUIREMENTS

KOPPERS-TOTZER/SING PROCESS

SYSTEM #	LAND UNIT	DIMENSIONS		AREA PER UNIT FT ² ACRES	\$/ACRE OR \$/FT ²	UNITS PER SYSTEM	TOTAL AREA PER SYSTEM, ACRES	TOTAL COST
		L	W					
SUBTOTAL LAND REQUIREMENT								
LAND SURVEY AND FEES*					\$3000		300	\$ 900,000
ALLOWANCE FOR INTERCONNECTIONS, SITE PREPARATION, MISCELLANEOUS*								\$ 4,000 \$ 260,000
SUBTOTAL DEPRECIABLE LAND RELATED EXPENSES					\$8100		300	\$2,430,000
TOTAL								\$2,694,000 \$3,594,000

* COSTS OBTAINED FROM MITTELHAUSER GUIDE TO ESTIMATE TOTAL CAPITAL REQUIREMENT FOR PROCESSING FACILITIES

THE BDM CORPORATION

TOTAL CAPITAL REQUIREMENTS KOPPER-TOTZEK/SNG PROCESS

ITEM DESCRIPTION	SNG MODULE 1	MBG MODULE 2	MBG MODULE 3	MBG MODULE 4	GENERAL FACILITIES	TOTAL
TOTAL FACILITY INVESTMENT	424.328	406.899	362.612	382.612	138.678	1735.129
OTHER CAPITALIZED COSTS	187.979	184.319	172.766	172.766	29.567	747.397
LAND RELATED COSTS					2.694	2.694
SUBTOTAL DEPRECIABLE INVESTMENT	612.307	591.218	555.378	555.378	170.939	2485.220
WORKING CAPITAL	26.854	26.775	19.389	19.389	.628	93.035
LAND					0.900	0.900
SUBTOTAL NON-DEPRECIABLE INVESTMENT	26.854	26.775	19.389	19.389	1.528	93.935
TOTAL CAPITAL REQUIREMENTS	639.161	617.993	574.767	574.767	172.467	2579.155

THE BDM CORPORATION

e. **Koppers - Totzek/SNG Operations and Maintenance Costs**

THE BDM CORPORATION

KOPPER-1012EN/SNG PROCESS MODULE OPERATIONS MANPOWER STAFFING REQUIREMENTS*

(INDIVIDUAL MANPOWER REQUIREMENTS FOR MODULES I AND II)

SYSTEM NO.	OPERATORS PER SHIFT	PER WEEK	UTILITY SHIFTS PER SHIFT	MAN PER SHIFT	SHIFTS PER WEEK	UNIT SUPPLY PER SHIFT	SHIFTS PER WEEK	TOTAL HOURS PER YEAR**
1	1	(\$21,600/yr)	5	1 (\$14,50/hr)	5	1 (\$34,500/yr)	5	6,240.
2	2	(\$14,000/yr)	5	1 (\$8,50/hr)	5	1 (\$24,000/yr)	5	8,320.
3	1	(\$13,000/yr)	5	1 (\$8,50/hr)	5	1 (\$24,000/yr)	5	6,240.
4	1	(\$21,600/yr)	5	1 (\$14,50/hr)	5	- INCLUDED IN UNIT 1	1	4,160.
5	-	-	-	-	-	-	-	-
6	0	-	0	1 (\$15,200/yr)	7	-	-	2,912.
7	1	(\$17,900/yr)	21	1 (\$13,100/yr)	7	1 (\$27,600/yr)	21	20,384.
8	1	(\$17,900/yr)	21	1 (\$13,100/yr)	21	1 (\$27,600/yr)	5	19,552.
9	-	-	-	-	-	-	-	-
10	2	(\$17,900/yr)	21	-	-	-	-	17,472.
11	0**	(\$17,900/yr)	21	1** (\$16,400/yr)	21	-	-	8,736.
12	2**	(\$20,300/yr)	21	2** (\$16,400/yr)	21	1 (\$27,600/yr)	21	43,680.
13	-	-	-	-	-	-	-	-
14	1	(\$20,300/yr)	21	1 (\$16,400/yr)	7	1 (\$27,600/yr)	5	13,728.
15	1	(\$17,900/yr)	21	-	-	-	-	8,736.
16	-	-	-	-	-	-	-	-
17	1	(\$17,900/yr)	21	0	0	1 (\$27,600/yr)	5	10,016.
18	1	(\$17,900/yr)	21	0	0	-	-	8,736.
19	-	-	-	-	-	-	-	-
20	5	(\$17,900/yr)	21	3 (\$16,400/yr)	7	2 (\$27,600/yr)	5	56,576.
							TOTALS	736,288.

* TOTAL STAFF - TOTAL STAFF $\frac{\text{HRS}}{\text{YR}} = \frac{\text{PERSONS} \times \text{HRS}}{\text{YR}} = 179,712 \div 2080 = 113.6$ (USE 113 OR 114 PERSONS)

** DEPENDENT ON GASIFICATION TECHNOLOGY USED. (NUMBER OF GASIFIERS & FEED SYSTEMS PER MODULE AND RELATIVE ATTENTION REQUIRED.)

*** TOTAL HRS PER YEAR = (OPER/SHIFT) \times (SHIFTS/UNIT) \times (B WKG HRS/OPER) \times ($\frac{52 \text{ WKS}}{\text{YEAR}}$)
(FOR EACH SYSTEM)

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THE BDM CORPORATION

MODULE OPERATING COST DATA

PROCESS: KOPPERS-TOTZEK/SNG PROCESS

ITEM: INDIVIDUAL STAFFING REQUIREMENTS COSTS
FOR MODULES I AND II

REFERENCE: TVA DESIGN CRITERIA AND STAFFING NEEDS
DEFINED BY BDM/MITTELHAUSER

METHOD: SYSTEM REQUIRES ONE MORE UTILITY PERSON
THAN B&W DUE TO NUMBER OF GASIFIERS

<u>JOB DESCRIPTION</u>	<u>COMPENSATION RATE</u>	<u>HRS/YEAR</u>	<u>BASE COST/YEAR</u>	<u>FRINGES</u>	<u>TOTAL</u>
<u>I. OPERATING LABOR</u>					
MECHANICAL UNIT					
FOREMAN	\$21,600/year	2,080	\$ 21,600	1.42	\$30,672
ELECTRICIAN	\$14.50/hr	2,080	\$ 30,160	0	30,160
COAL HANDLING					
FOREMAN	\$14.00/hr	4,160	\$ 58,240	0	58,240
LABORER	\$ 8.50/hr	4,160	\$ 35,360	0	35,360
HEAD OPERATOR	\$13.00/hr	2,080	\$ 27,040	0	27,040
INSTRUMENT UNIT					
FOREMAN	\$21,600/yr	2,080	\$ 21,600	1.42	30,672
INSTRUMENT					
MECHANIC	\$14.50/hr	2,080	\$ 30,160	0	30,160
CLASS C OPERATOR	\$15,200/yr	2,912	\$ 21,280*	1.42	30,218
CLASS A OPERATOR	\$17,900/yr	104,832	\$902,160	1.42	1,281,067
PLANT LABORER	\$13,100/yr	11,648	\$ 73,360	1.42	104,171
CLASS B OPERATOR	\$16,400/yr	37,856	\$298,480	1.42	423,842
UNIT OPERATOR	\$20,300/yr	<u>26,208</u>	\$255,780	1.42	<u>363,208</u>
SUBTOTAL OPERATING LABOR		202,176			\$2,444,810
<u>II. SUPERVISION</u>					
PLANT OPERATING					
SUPERVISOR	\$34,500/year	2,080	\$ 34,500	1.42	\$ 48,990
YARD OPERATIONS					
SUPERVISOR	\$24,000/year	4,160	48,000	1.42	68,160
SHIFT ENGINEER	\$27,600/year	<u>27,972</u>	369,840	1.42	<u>525,173</u>
SUBTOTAL SUPERVISION		34,112			\$642,323
TOTAL STAFF REQUIREMENTS		227,552			\$3,087,133

* WHEN COMPENSATION RATE IS GIVEN IN \$/OPER/YR

$$\text{BASE COST/YEAR} = [(\text{HRS/YEAR}) + (2080 \text{ HRS/OPER})] \cdot (\$/\text{OPER/YR})$$

THE BDM CORPORATION

KOPPERS-TOIZEK/SNG PROCESS OPERATING REQUIREMENTS FOR EXPECTED OPERATIONS

(INDIVIDUAL OPERATING REQUIREMENTS FOR MODULES I AND II)

	BASIS	UNITS
Raw Materials Coal	TPY @ 100% Operation	1,825,000 TPY
Catalyst and Chemical Makeup	@ 100% Operation	\$ 1,838,820 /Yr
Initial Charge of Catalysts & Chemicals		\$ 6,893,800
Utility Requirements Water Import Power Steam	Kwh/Yr @ 100% Operation	2,200 Gallons/Min 1,092,882,508 Kw-Hr/Yr
Operating Requirements Labor: Supervisors Operators	mh/Yr mh/Yr	34,112 202,176
Supplies	Factored as 15% of operating labor costs	
Maintenance Requirements Labor Supplies	Factored as 1.6% of average modular total system cost Factored as 2.4% of average modular total system cost	
General Plant Staff	Factored as 30% of operating labor and maintenance labor & supervision	
Administration and Plant Overhead	Factored as 5% of operating labor & maintenance less feedstock and chemicals	
TOTAL NET SNG YIELD	@ 100% Operation	19,464,720 MMBTU/YEAR

THE BDM CORPORATION

KOPPERS-TOTZEY/SNG PROCESS ANNUAL MODULE OPERATING COSTS FOR EXPECTED OPERATIONS (INDIVIDUAL COSTS FOR MODULES I AND II)

MILLIONS OF JANUARY 1980 DOLLARS

ITEM DESCRIPTION	UNITS	NET REQUIREMENTS (AT 100% OPERATION)	ANNUAL REQUIREMENTS (AT 90% OPERATION)	COST PER UNIT	ANNUAL COST ($\times 10^6$)
FEEDSTOCK: (KENTUCKY #9 SEAM, DEEP MINE)*	MMBTU	1.098×10^5 MMBTU/DAY	3.607×10^7 MMBTU/YEAR	\$1.25	\$ 45.087
CATALYST & CHEMICAL MAKE-UP					1.655
SUBTOTAL FEEDSTOCK & CATALYST & CHEMICALS					\$ 46.742
ELECTRIC POWER - PK/AVG. LOAD FACTOR = 1.5	KWH	124,758 KWH/HR.	983,594,257 KWH/YEAR	\$.027	26.557
WATER	10^3 GALLONS	2,200 GALLONS/MIN	1040.4×10^6 GALLONS/YR	\$.80/ K GAL	\$ 0.833
OPERATING LABOR	PERSON HRS.	202,176 HRS/YEAR	232,176 HRS/YEAR	\$12.09	\$ 2.444
OPERATING SUPPLIES	(15% OF OPERATING LABOR)				\$.367
MAINTENANCE LABOR	(1.6% OF 1/4 OF TFI)				\$ 6.941
MAINTENANCE SUPPLIES	(2.4% OF 1/4 OF TFI)				\$ 10.411
SUPERVISION	PERSON HRS.		34,112 HRS./YEAR	\$18.82	\$.642
GENERAL PLANT STAFF	(30% OF O.L. AND M.L. AND SUP)				\$ 3.008
ADMINISTRATION AND GENERAL OVERHEAD	(5% OF O&M LESS FEEDSTOCK AND CHEM.)				\$ 2.560
PROPERTY TAXES AND INSURANCE	DESIGN CRITERIA SPECIFY NO COSTS FOR THIS LINE ITEM				-0-
SUBTOTAL O&M COSTS LESS FEEDSTOCK & CATALYST & CHEMICALS					\$ 53.763
GROSS ANNUAL OPERATING & MAINTENANCE COSTS					\$100.505
BYPRODUCTS CREDITS					-0-
NET ANNUAL OPERATING & MAINTENANCE COSTS					<u>\$100.505</u>

* MEAN BTU VALUE OF FEEDSTOCK = 10,980 BTU/LB.

THE BDM CORPORATION

KOPPER-TOIZICK/MBG PROCESS MODULE OPERATIONS MANPOWER STAFFING REQUIREMENTS*

(INDIVIDUAL MANPOWER REQUIREMENTS FOR MODULES III AND IV)

SYSTEM NO.	OPERATORS PER SHIFT	PER WEEK	UTILITY SHIFTS PER SHIFT	MEN PER SHIFT	SHIFTS PER WEEK	UNIT SUPPS PER SHIFT	SHIFTS PER WEEK	TOTAL HOURS PER YEAR***
1	1	(\$21,600/yr)	5	1 (\$14.50/hr)	5	1 (\$34,500/yr)	5	6,240.
2	2	(\$14,000/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	8,320.
3	1	(\$13,000/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	6,240.
4	1	(\$21,600/hr)	5	1 (\$14.50/hr)	5	- INCLUDED IN UNIT 1	1	4,160.
5				INCLUDED IN UNIT 8				
6	0		0	1 (\$15,200/yr)	7	INCLUDED IN UNIT 14	14	2,912.
7	1	(\$17,900/yr)	21	1 (\$13,100/yr)	7	1 (\$27,600/yr)	21	20,384
8	1	(\$17,900/yr)	21	1 (\$13,100/yr)	21	1 (\$27,600/yr)	5	15,152
9				INCLUDED IN UNIT 7				
10	2	(\$17,900/yr)	21			INCLUDED IN UNIT 7	7	17,472.
11	0**	(\$17,900/yr)	21	1** (\$16,400/yr)	21	INCLUDED IN UNIT 12	12	8,736.
12	2**	(\$20,300/yr)	21	2** (\$16,400/yr)	21	1 (\$27,600/yr)	21	43,680.
13				INCLUDED IN UNIT 12				
14	1	(\$20,300/yr)	21	1 (\$16,400/yr)	7	1 (\$27,600/yr)	5	13,728.
15	1	(\$17,900/yr)	21			INCLUDED IN UNIT 3	3	8,736.
16				INCLUDED IN UNIT 12				
17	1	(\$17,900/yr)	21	0	0	1 (\$27,600/yr)	5	10,816.
18	1	(\$17,900/yr)	21	0	0	INCLUDED IN UNIT 14	14	8,736.
19				INCLUDED IN UNIT 8, IF REQUIRED				
						TOTALS		179,712.

* TOTAL STAFF = TOTAL STAFF $\frac{\text{HRS}}{\text{YR}} = \frac{\text{PERSON-HRS}}{\text{YR}} = 179,712 \div 2080 = 86.4$ (USE 86 OR 87 PERSONS)

** DEPENDENT ON GASIFICATION TECHNOLOGY USED. (NUMBER OF GASIFIERS & FEED SYSTEMS PER MODULE AND RELATIVE ATTENTION REQUIRED.)

*** TOTAL HRS PER YEAR = (OPER/SHIFT) * (SHIFTS/WEK) * (8 WKG HRS/OPER) * ($\frac{52 \text{ WKS}}{\text{YEAR}}$)
(FOR EACH SYSTEM)

THE BDM CORPORATION

MODULE OPERATING COST DATA

PROCESS: KOPPERS-TOTZEK/MBG PROCESS

ITEM: INDIVIDUAL STAFFING REQUIREMENTS COSTS
FOR MODULES III AND IV

REFERENCE: TVA DESIGN CRITERIA AND STAFFING NEEDS
DEFINED BY BDM/MITTELHAUSER

METHOD: SYSTEM REQUIRES ONE MORE UTILITY PERSON
THAN B&W DUE TO NUMBER OF GASIFIERS

<u>JOB DESCRIPTION</u>	<u>COMPENSATION RATE</u>	<u>HRS/YEAR</u>	<u>BASE COST/YEAR</u>	<u>FRINGES</u>	<u>TOTAL</u>
I. OPERATING LABOR					
MECHANICAL UNIT					
FOREMAN	\$21,600/year	2,080	\$ 21,600	1.42	\$30,672
ELECTRICIAN	\$14.50/hr	2,080	\$ 30,160	0	30,160
COAL HANDLING					
FOREMAN	\$14.00/hr	4,160	\$ 58,240	0	58,240
LABORER	\$ 8.50/hr	4,160	\$ 35,360	0	35,360
HEAD OPERATOR	\$13.00/hr	2,080	\$ 27,040	0	27,040
INSTRUMENT UNIT					
FOREMAN	\$21,600/yr	2,080	\$ 21,600	1.42	30,672
INSTRUMENT MECHANIC	\$14.50/hr	2,080	\$ 30,160	0	30,160
CLASS C OPERATOR	\$15,200/yr	2,912	\$ 21,280*	1.42	30,218
CLASS A OPERATOR	\$17,900/yr	61,152	\$526,260	1.42	747,289
PLANT LABORER	\$13,100/yr	11,648	\$ 73,360	1.42	104,171
CLASS B OPERATOR	\$16,400/yr	29,120	\$229,600	1.42	326,032
UNIT OPERATOR	\$20,300/yr	<u>26,208</u>	\$255,780	1.42	<u>363,208</u>
SUBTOTAL OPERATING LABOR		149,760			\$1,813,222
II. SUPERVISION					
PLANT OPERATING SUPERVISOR	\$34,500/year	2,080	\$ 34,500	1.42	\$ 48,990
YARD OPERATIONS SUPERVISOR	\$24,000/year	4,160	48,000	1.42	68,160
SHIFT ENGINEER	\$27,600/year	<u>23,712</u>	314,640	1.42	<u>446,789</u>
SUBTOTAL SUPERVISION		29,952			\$563,939
TOTAL STAFF REQUIREMENTS		179,712			\$2,377,161

* WHEN COMPENSATION RATE IS GIVEN IN \$/OPER/YR

$$\text{BASE COST/YEAR} = [(\text{HRS/YEAR}) + (2080 \text{ HRS/OPER})] \cdot (\$/\text{OPER/YR})$$

THE BDM CORPORATION

KOPPERS-TOTZEK/MBG PROCESS OPERATING REQUIREMENTS FOR EXPECTED OPERATIONS

(INDIVIDUAL OPERATING REQUIREMENTS FOR MODULES III AND IV)

	BASIS	UNITS
Raw Materials Coal	TPY @ 100% Operation	1,825,000 TPY
Catalyst and Chemical Makeup	@ 100% Operation	\$280,200 /Yr
Initial Charge of Catalysts & Chemicals		\$ 600,000
Utility Requirements Water		3,200 gpm
Import Power	Kwh/Yr @ 100% Operation	929,896,300 Kw-Hr/Yr
Steam		
Operating Requirements Labor:		
Supervisors	mh/Yr	29,952
Operators	mh/Yr	149,760
Supplies	Factored as 15% of operating labor costs	
Maintenance Requirements Labor	Factored as 1.6% of average modular total system cost	
Supplies	Factored as 2.4% of average modular total system cost	
General Plant Staff	Factored as 30% of operating labor and maintenance labor & supervision	
Administration and Plant Overhead	Factored as 5% of operations & maintenance less feedstock and chemicals	
TOTAL NET MBG YIELD	@ 100% Operation	25,022,940 MBTU/YEAR

THE BDM CORPORATION

KOPPERS-TOTZEK/MBG PROCESS ANNUAL MODULE OPERATING COSTS FOR EXPECTED OPERATIONS (INDIVIDUAL COSTS FOR MODULES III AND IV)

MILLIONS OF JANUARY 1980 DOLLARS

ITEM DESCRIPTION	UNITS	NET REQUIREMENTS (AT 100% OPERATION)	ANNUAL REQUIREMENTS (AT 90% OPERATION)	COST PER UNIT	ANNUAL COST ($\times 10^6$)
FEEDSTOCK: (KENTUCKY #9 SEAM, DEEP MINE)*	MMBTU	1.098×10^5 MMBTU/DAY	3.607×10^7 MMBTU/YEAR	\$1.25	\$45.087
CATALYST & CHEMICAL MAKE-UP					252
SUBTOTAL FEEDSTOCK & CATALYST & CHEMICALS					\$45.339
ELECTRIC POWER - PK/AVG. LOAD FACTOR = 1.5	KWH	106,152.5 KWH/MR.	836,906,670 KWH/YEAR	\$.027	22.596
WATER	10^3 GALLONS	4.608×10^6 GALLONS/DAY	1513.728×10^6 GALLONS/YR	\$.80/ K GAL	\$ 1.211
OPERATING LABOR	PERSON HRS.	149,760 HRS/YEAR	149,760 HRS/YEAR	\$12.11	\$ 1.814
OPERATING SUPPLIES	(15% OF OPERATING LABOR)				\$.272
MAINTENANCE LABOR	(1.6% OF 1/4 OF TFI)				\$ 6.941
MAINTENANCE SUPPLIES	(2.4% OF 1/4 OF TFI)				\$10.411
SUPERVISION	PERSON HRS.		29,952 HRS./YEAR	\$18.83	\$.564
GENERAL PLANT STAFF	(30% OF O.L. AND M.L. AND SUP)				\$ 2.795
ADMINISTRATION AND GENERAL OVERHEAD	(5% OF O&M LESS FEEDSTOCK AND CHEM.)				\$ 2.330
PROPERTY TAXES AND INSURANCE	DESIGN CRITERIA SPECIFY NO COSTS FOR THIS LINE ITEM				-0-
SUBTOTAL O&M COSTS LESS FEEDSTOCK & CATALYSTS & CHEMICALS					\$48.934
GROSS ANNUAL OPERATING & MAINTENANCE COSTS					\$94.273
BYPRODUCTS CREDITS					-0-
NET ANNUAL OPERATING & MAINTENANCE COSTS					<u>\$94.273</u>

* MEAN BTU VALUE OF FEEDSTOCK = 10,980 BTU/LB.

THE BDM CORPORATION

**f. Koppers - Totzek/SNG Present Value of Capital and Operations and
Maintenance Costs and Product Prices**

THE BDM CORPORATION

PRESENT VALUE OF CAPITAL AND OPERATING AND MAINTENANCE COSTS (AT 90 PERCENT OPERATING CAPACITY) KOPPER-S-101Z/SNG MILLIONS OF DOLLARS									
ITEM DESCRIPTION	GENERAL FACILITY	SNG MODULE 1	COMBINED 1-2	SNG MODULE 2	COMBINED 1-2-3-4	SNG MODULE 3	COMBINED 1-2-3-4	SNG MODULE 4	TOTAL FACILITY
OPERATING AND MAINTENANCE EXPENSES									
FEEDSTOCK CATALYST & CHEMICALS		496.95		477.68		468.11		458.01	
SUBTOTAL		18.24		17.53		2.62		2.57	
		515.19		495.21		470.73		461.38	
ELECTRIC POWER		263.04		251.30		209.06		204.66	
WATER		3.34		2.98		4.09		3.87	
OPERATING LABOR		25.09		24.10		17.52		17.16	
OPERATING SUPPLIES		3.76		3.61		2.63		2.57	
MAINTENANCE LABOR		73.15		70.23		68.79		67.41	
MAINTENANCE SUPPLIES		109.72		105.35		103.19		101.12	
SUPERVISION		6.59		6.33		5.45		5.34	
GENERAL PLANT		30.67		29.65		27.00		26.46	
ADMIN. & GENERAL		26.28		25.24		22.50		22.05	
PROPERTY TAXES & INS.		0.00		0.00		0.00		0.00	
SUBTOTAL		541.64		518.79		460.23		450.64	
SUBTOTAL O&M COSTS		1057.03		1014.00		930.96		912.02	3914.01
CAPITAL COSTS	147.32	519.32		489.55		456.30		448.96	
DEPRECIABLE INVESTMENT COSTS									
NON-DEPRECIABLE INVESTMENT COSTS	1.32	19.00		18.50		12.83		12.92	
SUBTOTAL CAPITAL COSTS	148.64	538.32		508.05		469.13		461.88	2126.02
PRESSENT VALUE OF TOTAL CAPITAL AND O&M COSTS	148.64	1595.35		1522.05		1400.09		1373.90	6040.03
SNG ANNUAL PRODUCT (MMBTU)		17518248		17518248		35036496		35036496	
MEG ANNUAL PRODUCT (MMBTU)		- 0 -		- 0 -		- 0 -		- 0 -	
PRODUCT PRICE (\$/MMBTU)		\$ 9.38		\$ 9.38		\$ 6.08		\$ 6.90	\$ 8.02
(JANUARY 1980 DOLLARS)		(FOR MODULE 2)		(FOR MODULES 1 & 2)		(FOR MODULE 3)		(FOR MODULES 3 & 4)	(ALL MODULES)
UNIFORM ANNUAL EQUIVALENT COST OF SERVICE (\$/MMBTU)		\$24.80		\$24.04		\$17.85		\$19.75	\$21.51
(CURRENT DOLLARS)									

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3. Koppers - Totzek and Texaco MBG and SNG

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THE BDM CORPORATION

- a. **Koppers - Totzek/SNG System Costs For Module I**

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THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	KOPPERS-TOTZEK/SNG
<u>SYSTEM:</u>	1-COAL PREPARATION & FEED
<u>UNIT OPERATION NUMBER:</u>	11
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	SEE SYSTEM 2 (SYSTEM 2 INCLUDES SYSTEMS 1 & 3)
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	N/A

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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 2-GASIFICATION
UNIT OPERATION NUMBER: 20
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: EPRI REPORT AF-531 p. 98
REFERENCE SYSTEM COST: \$51,063,000 (1974 DOLLARS)
REFERENCE CAPACITY: 11 GASIFIERS + 1 SPARE
TVA CAPACITY: 8 GASIFIERS + 1 SPARE
RECOMMENDED CAPACITY EXPONENT: 1

EXPLANATORY COMMENTS:

1. FACTOR LINEARLY ON GASIFIER QUANTITY
2. REFERENCE SYSTEM COST INCLUDES SYSTEMS 1 & 3
3. TOTAL 9 PARALLEL TRAINS REQUIRED FOR TVA.
4. BLOWER COST MUST BE DELETED FROM K/T REFERENCE COST PRIOR TO CAPACITY FACTORING. TOTAL BLOWER SYSTEM COST = \$985,600 (1974 DOLLARS)

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR) x
ESCALATION FACTOR x CAPACITY FACTOR

TOTAL DIRECT COST = REFERENCE SYSTEM COST - BLOWER SYSTEM COST

BLOWER SYSTEM COST = EQUIPMENT COST (1974 DOLLARS) x MODULAR FACTOR

INPUTS:

REFERENCE SYSTEM COST: $\$51.063 \times 10^6$ (JANUARY 1974 DOLLARS)
INDIRECT COST FACTOR: 0.36 (ASSUME "NORM" .36 L/M RATIO FOR MIXED PROCESS)
ESCALATION FACTOR: 1.51 (TO JANUARY 1980 DOLLARS)
CAPACITY FACTOR: .75
EQUIPMENT COST: \$985,600 (1974 DOLLARS)
MODULAR FACTOR: 2.2

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SYSTEM COST DATA (CONTINUED)

RESULTS:

BLOWER SYSTEM COST	=	$\$2.168 \times 10^6$	(JANUARY 1974 DOLLARS)
TOTAL DIRECT COST	=	$\$48.895 \times 10^6$	(JANUARY 1974 DOLLARS)
TOTAL SYSTEM COST	=	\$75,308,079	(JANUARY 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	KOPPERS-TOTZEK/SNG
<u>SYSTEM:</u>	3-INITIAL GAS CLEAN-UP & COOLING
<u>UNIT OPERATION NUMBER:</u>	21
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	SEE SYSTEM 2
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	N/A
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	N/A

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 1, 2, 3
COAL PREPARATION, FEED, GASIFICATION, INITIAL GAS CLEAN-UP & COOLING

SYSTEM CAPITAL INVESTMENT TABLE

SNG
MODULE
1

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

SUBTOTAL:

\$75.308

TOTAL PROCESS CONTINGENCY - 15%

SUBTOTAL:

\$ 11.296

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 86.604

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 4-ACID GAS REMOVAL - RECTISOL
UNIT OPERATION NUMBER: 22
REFERENCE SOURCE FOR COSTING: C.F. BRAUN
FE - 2240-31
FACTORED ESTIMATES EASTERN COAL
COMMERCIAL CONCEPT
REFERENCE SYSTEM COST: \$32,270,000 (1977 DOLLARS)
(INSTALLED COST)
REFERENCE CAPACITY: 13,827 LB MOLE/HR
TVA CAPACITY: 12,378 LB MOLE/HR
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS:

- (1) THE SELEXOL CIRCULATION RATES SHOWN WERE ESTIMATED FROM AN ALLIED CHEMICAL PROPOSAL (PROJ #337) TO FLUOR, DATED DECEMBER 3, 1975.

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST x CAPACITY FACTOR
x ESCALATION FACTOR

CAPACITY FACTOR = $\left(\frac{\text{TVA LB MOLE/HR}}{\text{REF LB MOLE/HR}} \right)^{0.6}$

INPUTS:

REFERENCE SYSTEM COST: 32.27×10^6 (1977 DOLLARS)

CAPACITY FACTOR: $\left(\frac{12,378}{13,827} \right)^{0.6} = .936$

ESCALATION FACTOR: 1.22 (TO JANUARY 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = 36.850×10^6 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
 KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 4, ACID GAS REMOVAL
 SUBSYSTEM INVESTMENT AGGREGATION TABLE
SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	SNG MODULE 1
TOTAL DIRECT PLUS INDIRECT COSTS SUBSYSTEM: RECTISOL UNIT	\$36.850
<u>SYSTEM SUBTOTAL:</u>	\$36.850
TOTAL PROCESS CONTINGENCY: 5% SUBSYSTEM: RECTISOL UNIT	
<u>SUBTOTAL:</u>	\$ 1.843
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$38.693

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 5-SULFUR RECOVERY & TAILGAS TREATMENT
UNIT OPERATION NUMBER: 36
REFERENCE SOURCE FOR COSTING: DOE REPORT FE-1775-18, PLANT 2, p. 9-13
REFERENCE SYSTEM COST: \$9,032,000 MID-1977 DOLLARS (TOTAL DIRECT COSTS)
REFERENCE CAPACITY: 181.2 LT/D SULFUR PRODUCT
TVA CAPACITY: 165.2 LT/D SULFUR PRODUCT
RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

1. PROCESS NOTE: NORMAL OPERATING RATE OF PLANT 2 IS 240 M/H FEED ALTHOUGH DESIGN IS FOR 527.5 M/H.
2. PROVIDE 2 TRAINS FOR MODULE 1 (1 SPARE).

COMPUTATION METHOD:

$$\begin{aligned}\text{CAPACITY FACTOR} &= \left(\frac{\text{TVA CAP}}{\text{REF CAP}} \right)^{0.6} \\ \text{SINGLE TRAIN COST} &= \text{TOTAL DIRECT COST} \times (1 + \text{INDIRECT COST FACTOR}) \\ &\quad \times \text{CAPACITY FACTOR} \times \text{ESCALATION FACTOR} \\ \text{TOTAL SYSTEM COST} &= \text{SINGLE TRAIN COST} \times \text{NO. OF TRAINS}\end{aligned}$$

INPUTS:

$$\begin{aligned}\text{TOTAL DIRECT COSTS} &= \$9.032 \times 10^6 \text{ (MID-1977 DOLLARS)} \\ \text{INDIRECT COST FACTOR} &= 0.10 \text{ (ASSUMED FROM DOE REPORT)} \\ \text{CAPACITY FACTOR} &= \left(\frac{165.2}{181.2} \right)^{0.6} = .946\end{aligned}$$

THE BDM CORPORATION

SYSTEM COST DATA (CONTINUED)

ESCALATION FACTOR = 1.22 (FROM 1977 to 1980 DOLLARS)

RESULTS:

SINGLE TRAIN COST = \$11,466,413

TOTAL SYSTEM COST:

MODULE 1 = \$22,932,826 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
 KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 5, SULFUR RECOVERY & TAILGAS TREATMENT
 SUBSYSTEM INVESTMENT/AGGREGATION TABLE

SNG
 MODULE
 1

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

\$ 22.933

SYSTEM SUBTOTAL:

TOTAL PROCESS CONTINGENCY: 15%

\$ 3.440

SYSTEM SUBTOTAL:

\$ 26.373

TOTAL SYSTEM CAPITAL INVESTMENT:

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG

SYSTEM: 6-AIR SEPARATION

UNIT OPERATION NUMBER: 80

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: COST ESTIMATING - RELATIONSHIP CURVES
(REFER TO AIR SEPARATION ATTACHMENT)

REFERENCE SYSTEM COST: $\$36.8 \times 10^6$ (JANUARY 1980 DOLLARS PER TRAIN)

REFERENCE CAPACITY: 4,104 TPD AIR SEPARATION PLANT OR 2,052
TPD FOR TWO AIR SEPARATION PLANTS @ 24.7
psia OXYGEN.

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THE SYSTEM CONSISTS OF TWO TRAINS FOR THE MODULE.
2. THE INSTALLATION COST OF THE 1st TRAIN IN MODULE 1 DIFFERS FROM THE OTHERS. FIRST TRAIN COSTS INCLUDE $\$1.1 \times 10^6$ FOR ELECTRIC MOTOR DRIVE FOR THE AIR AND OXYGEN COMPRESSORS.

COMPUTATION METHOD:

TOTAL SYSTEM COST:
MODULE 1 = INSTALLED COST FOR TWO TRAINS

INPUTS:

TRAIN COSTS (MODULE 1):

1st - $\$37.9 \times 10^6$ (JANUARY 1980 DOLLARS)

2nd - 36.8×10^6 (JANUARY 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST: MODULE 1 = $\$74.7 \times 10^6$ (JANUARY 1980 DOLLARS)

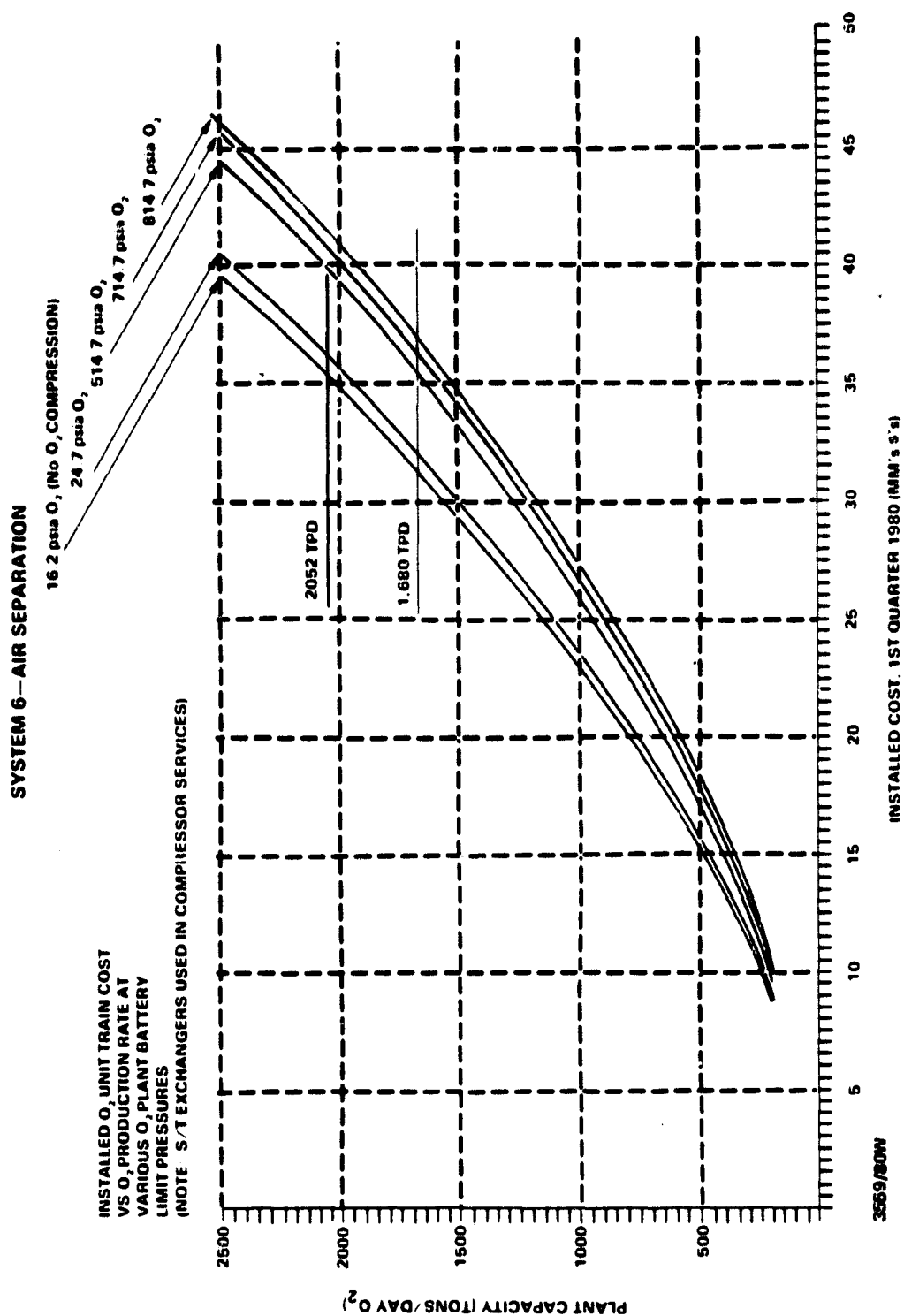


Figure III-1. Air Separation Plant Installed Cost for the Koppers-Totzek/SNG Process

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 6, AIR SEPARATION SYSTEM CAPITAL INVESTMENT TABLE

SNG
MODULE
1

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

SUBTOTAL:

\$74.70

TOTAL PROCESS CONTINGENCY: 0%

SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT

\$74.70

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 7-GAS COMPRESSION
UNIT OPERATION NUMBER: 23
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: VENDOR ESTIMATE
REFERENCE SYSTEM COST: \$10,529,000 (JANUARY 1980 DOLLARS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 14,720,000
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:
1. 1 TRAIN PER MODULE.
2. PRICE INCLUDES MOTOR DRIVERS.
3. COST IS EQUIPMENT ONLY.
4. USE 2.15 INSTALLED COST FACTOR PER GUTHRIE, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL. p. 167.

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST x MODULAR FACTOR

INPUTS:

REFERENCE SYSTEM COST: $\$10.529 \times 10^6$ (JANUARY 1980 DOLLARS)

MODULAR FACTOR: 2.15

RESULTS:

TOTAL SYSTEM COST = $\$22.638 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
 KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 7, GAS COMPRESSION
SYSTEM CAPITAL INVESTMENT TABLE

SNG
 MODULE
 1

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

SUBTOTAL:

\$22.638

TOTAL PROCESS CONTINGENCY: -0%

SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 22.638

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 8-PROCESS SOLIDS TREATMENT (DEWATERING)
UNIT OPERATION NUMBER: 31
SUBSYSTEM: WATER TREATMENT-SLUDGE HANDLING
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: \$75,000 JANUARY 1980 DOLLARS
(TOTAL DIRECT COSTS)
(SEE TOTAL DIRECT COSTS BELOW)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 16,000 GAL/DAY OF 15% BY WEIGHT OF LIME
SLUDGE
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SUBSYSTEM COST: = TOTAL DIRECT COST x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS:

1.	2 LINED PONDS FOR GRAVITY DEWATERING	\$60,000
2.	25% CONTINGENCY FOR ANY CONVEYORS, PUMPS, CHEMICAL FEED, EQUIPMENT, ETC.	15,000
	TOTAL	\$75,000

INDIRECT COST FACTOR: 0.335 (ASSUME .25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SUBSYSTEM COST = \$100,125 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 8-PROCESS SOLIDS TREATMENT (DEWATERING)
UNIT OPERATION NUMBER: 31
SUBSYSTEM: GASIFIER SLAG DEWATERER
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: \$569,000 JANUARY 1980 DOLLARS (TOTAL DIRECT COST) (SEE TOTAL DIRECT COSTS BELOW)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 60,000 #/HR SLAG & ASH
21,420 #/HR H₂O
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

$$\text{TOTAL SUBSYSTEM COST} = \text{TOTAL DIRECT COST} \times (1 + \text{INDIRECT COST FACTOR})$$

INPUTS:

TOTAL DIRECT COSTS

1.	GRAVITY CLARIFIER	\$ 40,000
2.	CONVEYOR TO DISPOSAL PILE	513,000
3.	CHEMICAL FEED	16,000
	TOTAL	\$569,000 (JANUARY 1980 DOLLARS)

INDIRECT COST FACTOR: 0.335 (ASSUME 0.25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

$$\text{TOTAL SUBSYSTEM COST} = \$759,615 \text{ (JANUARY 1980 DOLLARS)}$$

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 8, PROCESS SOLIDS TREATMENT (DEWATERING)

SYSTEM CAPITAL INVESTMENT TABLE

SNG
MODULE
1

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS
SUBSYSTEM: WATER TREATMENT
 SLUDGE HANDLING
SUBSYSTEM: GASIFIER SLAG
 DEWATERER

\$.100

\$.760

SYSTEM SUBTOTAL:

\$.860

TOTAL PROCESS CONTINGENCY: -0%

SYSTEM SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$.860

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	KOPPERS-TOTZEK/SNG
<u>SYSTEM:</u>	9- INCINERATION
<u>UNIT OPERATION NUMBER:</u>	N/A
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	N/A
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPABILITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	INCINERATION SYSTEM IS NOT REQUIRED IN THE GASIFICATION PROCESS.

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SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 10-INSTRUMENTATION & CONTROL
UNIT OPERATION NUMBER: N/A
SUBSYSTEM: N/A
REFERENCE SOURCE FOR COSTING: VENDOR ESTIMATE FROM GENERAL ELECTRIC
REFERENCE SYSTEM COST: $\$1.5 \times 10^6$ (JANUARY 1980 DOLLARS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THIS SYSTEM CONTAINS JUST THE NECESSARY MATERIAL FOR THE CENTRALIZED REMOTE FACILITY. IT CONTAINS SUFFICIENT CABLE TO TRANSMIT SIGNALS FROM THE PROCESS UNITS: DATA PROCESSING EQUIPMENT, SOFTWARE PACKAGES FOR THE ANALYSIS OF INCOMING DATA, AND DISPLAY PANELS FOR PRESENTATION OF DATA. THIS SYSTEM DOES NOT INCLUDE LOCAL CONTROLS FOR DIRECT OPERATION OF INDIVIDUAL SYSTEMS.
2. IT IS BASED UPON A HONEYWELL 4500 SYSTEM.

COMPUTATION METHOD:

TOTAL DIRECT COST = (1 + INSTALLATION FACTOR) x REFERENCE EQUIPMENT COST

TOTAL SYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

FIELD INSTALLATION FACTOR = 1.10 (ASSUMED)

REFERENCE COST = $\$1.5 \times 10^6$ (JANUARY 1980 DOLLARS)

INDIRECT COST FACTOR = 0.289 (90/10 ASSUMED M/L RATIO)

RESULTS:

TOTAL DIRECT COSTS = $\$3.15 \times 10^6$ (JANUARY 1980 DOLLARS)

TOTAL SYSTEM COST = $\$4.06 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 10, INSTRUMENTATION & CONTROL
SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	SNG MODULE 1
TOTAL DIRECT PLUS INDIRECT COSTS	
<u>SUBTOTAL:</u>	\$ 4.06
TOTAL PROCESS CONTINGENCY: 15%	
<u>SUBTOTAL:</u>	\$ 0.609
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 4.669

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	KOPPERS-TOTZEK/SNG
<u>SYSTEM:</u>	11-COAL HANDLING
<u>UNIT OPERATION:</u>	10
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	N/A
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A

EXPLANATORY COMMENTS:

COAL HANDLING SYSTEM IS INCLUDED UNDER GENERAL FACILITIES SYSTEMS LISTING SINCE IT IS DESIGNED TO SERVE ALL FOUR MODULES.

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG

SYSTEM: 12-SOLIDS WASTE RECYCLING/DISPOSAL

UNIT OPERATION NUMBER: 81

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATE (FROM IN-HOUSE COST DATA BASE)

REFERENCE SYSTEM COST: $\$16.1 \times 10^6$ (JANUARY 1980 DOLLARS) (TOTAL DIRECT COSTS)

DIRECT COST OF SOLIDS DISPOSAL AREA	=	$\$10.0 \times 10^6$
DIRECT COST OF RUNOFF COLLECTION BASIN	=	$\$6.1 \times 10^6$
(BOTH ARE LINED W/CLAY LINER)		$\$16.1 \times 10^6$

REFERENCE CAPACITY: N/A

TVA CAPACITY: 61,000 #/HR SOLIDS (DRY), 2,319 GAL/HR H₂O WITH SOLIDS

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. SYSTEM IS ESSENTIALLY AN EXCAVATED AREA FOR 20 YEARS OF SOLID DISPOSAL. INCLUDES EXCAVATION & CONSTRUCT OF CLAY-LINED DISPOSAL AREA RUNOFF HOLDING POND.
2. LAND COSTS WERE NOT INCLUDED.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COST: $\$16.1 \times 10^6$ (JANUARY 1980 DOLLARS)
INDIRECT COST FACTOR: 0.335 (80/20 ASSUMED M/L RATIO FOR SOLIDS HANDLING SYSTEMS)

RESULTS:

TOTAL SYSTEM COST = $\$21.494 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 12, SOLIDS WASTE RECYCLING/DISPOSAL

SYSTEM CAPITAL INVESTMENT TABLE

KOPPERS		SNG
<u>ITEM DESCRIPTION 81 FINAL SOLIDS</u>		MODULE
<u>DISPOSAL</u>		1
TOTAL DIRECT PLUS INDIRECT COSTS		\$ 13.350
SUBSYSTEM: LINED DISPOSAL AREA		\$ 8.144
SUBSYSTEM: RUNOFF COLLECTION		\$ 21.494
SYSTEM SUBTOTAL:		

TOTAL PROCESS CONTINGENCY: -0%

SYSTEM SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 21.494

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	KOPPERS-TOTZEK/SNG
<u>SYSTEM:</u>	13-BYPRODUCTS PROCESSING
<u>UNIT OPERATION NUMBER:</u>	83
<u>SUBSYSTEM:</u>	SULFUR STORAGE AND LOADING
<u>REFERENCE SOURCE FOR COSTING:</u>	MITTELHAUSER IN-HOUSE COST DATA BASE
<u>REFERENCE SYSTEM COST:</u>	$\$1 \times 10^6$ (JANUARY 1980 DOLLARS)
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	1. ORDER OF MAGNITUDE ESTIMATE OF 1×10^6 BASED ON UPON FLAKING SULFUR STORAGE FACILITY RATHER THAN PRILL TOWER.
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	
TOTAL SYSTEM COST = $\$1 \times 10^6$ (JANUARY 1980 DOLLARS)	

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
 KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 13, BYPRODUCTS PROCESSING
 SUBSYSTEM INVESTMENT/AGGREGATION TABLE

SNG
 MODULE
 1

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS
 UNIT OPERATIONS 83-SULFUR
 STORAGE AND LOADING
SYSTEM SUBTOTAL:

\$ 1.0

TOTAL PROCESS CONTINGENCY: 0%

-0-

SYSTEM SUBTOTAL:

\$ 1.0

TOTAL SYSTEM CAPITAL INVESTMENT:

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG

SYSTEM: 14-PLANT POWER SYSTEM

UNIT OPERATION NUMBER: 87

SUBSYSTEM: PLANT ELECTRICAL DISTRIBUTION

REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA, FROM
PROCESS PLANT ESTIMATING, EVALUATION
AND CONTROL. p. 363.

REFERENCE SYSTEM COST: \$102.60 (1970 DOLLARS/KILOWATT) (FACTOR
FOR ELECTRICAL DISTRIBUTION, FIELD INSTAL-
LATION COSTS IN NORMAL RANGE)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 117,947 KWATT

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS SYSTEM CONTAINS NO POWER GENERATING CAPACITY. SYSTEM COSTS REPRESENT
ONLY CAPITAL REQUIREMENTS FOR POWER DISTRIBUTION.

COMPUTATION METHOD:

TOTAL SYSTEM COST = KILOWATT REQUIREMENT x TOTAL DIRECT COST FACTOR x
(1 + INDIRECT COST FACTOR) x ESCALATION FACTOR

INPUTS:

KILOWATT REQUIREMENT = 117,947 kw
TOTAL DIRECT COST FACTOR = \$102.62 (1970 DOLLARS/PER KILOWATT)
INDIRECT COST FACTOR = 0.469 (BASED ON 0.72 L/M RATIO)
ESCALATION FACTOR = 1.988 (FROM 1970 TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$35.347 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 14, PLANT POWER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

SNG
MODULE
1

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

SUBTOTAL:

\$ 35.347

TOTAL PROCESS CONTINGENCY: 0%

SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 35.347

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG

SYSTEM: 15-STEAM GENERATION/DISTRIBUTION

UNIT OPERATION NUMBER: 84

SUBSYSTEM: DISTRIBUTION

REFERENCE SOURCE FOR COSTING: GUTHRIE COST REFERENCE DATA, PROCESS PLANT
ESTIMATING, EVALUATION AND CONTROL, p. 365

REFERENCE SYSTEM COST: TOTAL DIRECT COST FACTOR = 1.68 (1970 DOLLARS
PER LBS PER HR)

REFERENCE CAPACITY: N/A

TVA CAPACITY: STEAM REQUIREMENT = 1,375,000 LB/HR.
(FOR MODULE 1)

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. SYSTEM DESIGN DOES NOT REQUIRE ANY INDEPENDENT STEAM GENERATION CAPACITY. SYSTEM COSTS REPRESENT DISTRIBUTION REQUIREMENTS INCLUDING PIPING, TRAPS, AND SUPERHEATERS.
2. THE STEAM REQUIREMENT HAS BEEN INCREASED OVER THE BASE CASE TO PROVIDE A CONTINGENCY TO COVER THE STEAM REQUIREMENTS IN THE ALTERNATIVE PRODUCTS CASE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = STEAM REQUIREMENT x TOTAL DIRECT COST FACTOR x (1 +
INDIRECT COST FACTOR) x ESCALATION FACTOR

INPUTS:

STEAM REQUIREMENT = 1,375,000 LB/HR (FOR MODULE 1)
TOTAL DIRECT COST FACTOR = \$1.68 (1970 DOLLARS/PER LBS/HR)
INDIRECT COST FACTOR = 0.488 (BASED ON AN L/M RATIO OF 0.82)
ESCALATION FACTOR = 1.988 (TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$6.833 x 10⁶ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 15, STEAM GENERATION/DISTRIBUTION

SYSTEM CAPITAL INVESTMENT TABLE

SNG
MODULE
1

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

SUBTOTAL:

\$ 6.833

TOTAL PROCESS CONTINGENCY: 0%

SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 6.833

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG

SYSTEM: 16-WATER SUPPLY

UNIT OPERATION NUMBER: 85

SUBSYSTEM: BULK WATER TREATING

REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATED DESIGN EQUIPMENT COSTS (SEE BELOW)

REFERENCE SYSTEM COST: $\$.880 \times 10^6$ JANUARY 1980 DOLLARS (TOTAL DIRECT COSTS) - SEE BELOW

REFERENCE CAPACITY: N/A

TVA CAPACITY: 4,000 gpm (DESIGN)

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

$$\text{TOTAL SYSTEM COST} = \text{TOTAL DIRECT COSTS} \times (1 + \text{INDIRECT COST FACTOR})$$

INPUTS:

TOTAL DIRECT COSTS:

1. FIREWATER POND - DIKED CLAY LINED (EXCL. LAND)	\$192,000
2. CLARIFIER-SOFTENER - 76'-0" EQUIPMENT	293,000
INSTALLATION	287,000
3. CHEMICAL FEED SYSTEM (INC. PUMPS & MIX TANKS)	
POLYMER	18,000
LIME	50,000
4. RECARBONATION (ASSUME LIQUID CO ₂ FEED SYSTEM)	40,000
TOTAL	\$880,000

INDIRECT COST FACTOR = 0.37 (ASSUME .365 L/M RATIO FOR CHEMICAL PROCESS)

RESULTS:

$$\text{TOTAL SYSTEM COST} = \$1.190 \times 10^6 \text{ (JANUARY 1980 DOLLARS)}$$

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 16-WATER SUPPLY
UNIT OPERATION NUMBER: 85
SUBSYSTEM: BOILER FEEDWATER TREATING (RESIN DEMIN)
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE
(SEE BELOW)
REFERENCE SYSTEM COST: \$3,115,000 (JANUARY 1980 DOLLARS) (TOTAL
DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 400gpm (DESIGN)
RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

1. SUBSYSTEM CONSISTS OF 2 PARALLEL TRAINS TO ALLOW FOR REGENERATION OF 1 TRAIN WHILE THE OTHER TRAIN IS ON STREAM. ASSUMED THE SUBSYSTEM WILL SUPPLY BFW FOR 1 MODULE. INCLUDES INSTALLED SKID MOUNTED CATION, ANION & MIXED RESIN BEDS, PUMPS, INTERCONNECT PIPING, VALVES, INSTRUMENTS, AND DEAERATOR.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS:	
DEMIN EQUIPMENT COST	= \$1,930,000
INSTALLATION COST	= \$ 960,000
REGEN STORAGE TANK COST	= \$ 62,000 (INSTALLED) 2-5000 GAL TANKS (C.S)
FILTERS (PRESSURE)	= \$ 163,000
	<u>\$3,115,000</u> JANUARY 1980 DOLLARS (TOTAL DIRECT COSTS)

INDIRECT COST FACTOR: 0.37 (ASSUMED .365 L/M RATIO FOR CHEMICAL PROCESS)

RESULTS:

TOTAL SYSTEM COST = \$4,267,550 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 16, WATER SUPPLY

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE</u>
TOTAL DIRECT PLUS INDIRECT COSTS	
SUBSYSTEM-BULK WATER TREATING	\$ 1.190
SUBSYSTEM-BOILER FEEDWATER TREATING	\$ 4.268
<u>SYSTEM SUBTOTAL:</u>	\$ 5.458

TOTAL PROCESS CONTINGENCY: 0%

<u>SYSTEM SUBTOTAL:</u>	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 5.458

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SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG

SYSTEM: 17-COOLING WATER SYSTEM

UNIT OPERATION NUMBER: 39

SUBSYSTEM: UTILITY COOLING TOWER

REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST ESTIMATE

REFERENCE SYSTEM COST: $\$3.5 \times 10^6$ JANUARY 1980 DOLLARS (TOTAL DIRECT COSTS)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 60,000 GPM

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS COST REFLECTS A REDUCTION IN COOLING TOWER CAPACITY FROM 75,000 IN TASK 5.2.1 TO 60,000 ABOVE.

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS = $\$3.5 \times 10^6$ (JANUARY 1980 DOLLARS)
INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)

RESULTS:

TOTAL SUBSYSTEM COST = $\$4.76 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 17-COOLING WATER SYSTEM
UNIT OPERATION NUMBER: 39
SUBSYSTEM: BLOWDOWN TREATMENT
REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST ESTIMATE
REFERENCE SUBSYSTEM COST: \$932,617 JANUARY 1980 DOLLARS (TOTAL DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 46 gpm
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS:

SUBSYSTEM CONSISTS OF 1 VAPOR COMPRESSION UNIT
(INSTALLED) = \$932,617

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS: \$932,617 JANUARY 1980 DOLLARS
INDIRECT COST FACTOR: 0.36 (ASSUMED "NORMAL" .36 L/M RATIO FOR MIXED PROCESS)

RESULTS:

TOTAL SUBSYSTEM COST = \$1,268,359 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	KOPPERS-TOTZEK/SNG
<u>SYSTEM:</u>	17-COOLING WATER SYSTEM
<u>UNIT OPERATION NUMBER:</u>	39
<u>SUBSYSTEM:</u>	GASIFIER COOLING TOWER
<u>REFERENCE SOURCE FOR COSTING:</u>	SEE BELOW
<u>REFERENCE SUBSYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A

EXPLANATORY COMMENTS:

1. THIS ITEM IS TO BE DELETED FROM THIS COST ESTIMATE, SINCE THIS GASIFIER COOLING TOWER IS INCLUDED IN SYSTEM 2.

<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	N/A

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 17, COOLING WATER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	SNG MODULE 1
TOTAL DIRECT PLUS INDIRECT COSTS	
SUBSYSTEM: GASIFIER COOLING TOWER	\$ 4.76
SUBSYSTEM: BLOWDOWN TREATMENT	\$ 1.268
<u>SUBTOTAL:</u>	\$ 6.028

TOTAL PROCESS CONTINGENCY: 0%

SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$ 6.028

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG
SYSTEM: 18-WASTE WATER TREATMENT
UNIT OPERATION NUMBER: 33
SUBSYSTEM: PROCESS CONDENSATE TREATMENT
REFERENCE SOURCE FOR COSTING: MITTELHAUSER ESTIMATE
REFERENCE SUBSYSTEM COST: \$.152 x 10⁶ JANUARY 1980 DOLLARS (TOTAL DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 19,300 GAL/HR
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS: \$.152 x 10⁶ (JANUARY 1980 DOLLARS)
INDIRECT COST FACTOR: 0.37 (ASSUME .365 L/M RATIO FOR CHEMICAL PROCESS)

RESULTS:

TOTAL SUBSYSTEM COST = \$208,240 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 18, WASTE WATER TREATMENT

SUBSYSTEM INVESTMENT/AGGREGATION TABLE

SNG MODULE 1	\$.208
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TOTAL DIRECT PLUS INDIRECT COSTS

SYSTEM SUBTOTAL:

TOTAL PROCESS CONTINGENCY: 0%

SYSTEM SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$.208

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- b. **Texaco/SNG System Costs For Modules II, III, & IV**

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SYSTEM COST DATA

PROCESS: TEXACO/SNG
SYSTEM: 1 - COAL PREPARATION AND FEEDING
UNIT OPERATION NUMBER: 11
REFERENCE SOURCE: AF-642, CASE EXTC
REFERENCE SYSTEM COST: N/A
REFERENCE CAPACITY: N/A
TVA CAPACITY: N/A
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS SYSTEM IS COMBINED WITH SYSTEM 2 GASIFICATION IN THE REFERENCE SOURCE AF-642, EXTC. SEE SYSTEM 2, COSTING.

COMPUTATION METHOD: N/A
INPUTS: N/A
RESULTS: N/A

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SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 2 - GASIFICATION

UNIT OPERATION NUMBER: 20

REFERENCE SOURCE: EPRI AF-642, CASE EXTC (SLURRY FEED).
CATEGORY LISTED AS UNIT 20 - "GASIFICATION AND ASH HANDLING."

REFERENCE SYSTEM COST: \$24.261 X 10⁶ (MID-1976 DOLLARS)

REFERENCE CAPACITY: 5 GASIFIERS PLUS 1 SPARE

TVA CAPACITY: 3 GASIFIERS PLUS 1 SPARE

RECOMMENDED CAPACITY EXPONENT: 1

EXPLANATORY COMMENTS:

1. FACTOR THE COMBINED TVA SYSTEMS 1 AND 2 TO THE REFERENCE DESIGN BY A LINEAR 4/6 FACTOR.
2. REFERENCE COST INCLUDES SYSTEM 1.

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE COST x CAPACITY FACTOR x
ESCALATION FACTOR

INPUTS

REFERENCE COSTS = \$24.261 x 10⁶ (MID-1976 DOLLARS)

CAPACITY FACTOR = 2/3

ESCALATION FACTOR = 1.30 (TO JANUARY 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$21.026 X 10⁶ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

TEXACO/SNG PROCESS, SYSTEM NO. 1, 2 - COAL PREPARATION, FEED, & GASIFICATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>MBG MODULE 3</u>	<u>MBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS <u>SUBTOTAL:</u>	\$21.026	\$21.026	\$21.026
TOTAL PROCESS CONTINGENCY - 15%			
<u>SUBTOTAL:</u>	3.154	3.154	3.154
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$24.180	\$24.180	\$24.180

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SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 3 - INITIAL GAS CLEAN-UP AND COOLING

UNIT OPERATION NUMBER: 21

REFERENCE SOURCE: GUTHRIE, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL.

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THE TVA/TEXACO GAS COOLING SYSTEM WAS DESIGNED AT THE EQUIPMENT LEVEL AND EACH MAJOR EQUIPMENT ITEM PRICED BASED UPON GUTHRIE, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL.
2. SEE ATTACHED PAGE #2 (FOR A LISTING OF ALL OF THE EQUIPMENT COSTS) (MID-1978 DOLLARS)

COMPUTATION METHOD: N/A

INPUT: N/A

RESULTS:

TOTAL SYSTEM COST = $\$13.813 \times 10^6$
(JANUARY 1980 DOLLARS)
(REFER TO FOLLOWING PAGES)

THE BDM CORPORATION

TEXACO/SNG

SYSTEM COST DATA

3 - INITIAL GAS CLEAN-UP AND COOLING

<u>Item</u>	<u>Type</u>	(B) (Mid-1978) Base Equipment Cost-Each	(E) (Mid-1978) Equipment Cost-Each	<u>Number Required</u>
3-E-1	Shell & Tube Heat Exgr.	\$114,000	\$537,000	5
3-E-2	Shell & Tube Heat Exgr.	88,000	402,000	2
3-E-3	Shell & Tube Heat Exgr.	122,000	371,000	1
3-E-4	Air Cooled Heat Exgr.	137,000	449,000	4
3-E-5	Shell & Tube Heat Exgr.	59,000	153,000	1
3-V-1	Vertical Vessel	\$ 17,000	\$ 56,000	1
3-V-2	Vertical Vessel	15,000	50,000	1
3-V-3	Vertical Vessel	13,000	44,000	1
3-V-4	Vertical Vessel	12,500	41,000	1
3-V-5	Vertical Vessel	30,000	91,000	1
3-P-1	Centrifugal Pump & Motor	\$ 13,700	\$ 31,000	3
3-P-2	Centrifugal Pump & Motor	2,000	5,000	3
3-P-3	Centrifugal Pump & Motor	2,300	6,000	3
3-ME-1	Gas Scrubbing Subsystem	\$ 65,000	\$200,000	1

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TEXACO/SNG

SUBSYSTEM COST DATA

3 - Initial Gas Clean-up & Cooling

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 3-E-1 through 5

Category: Heat Exchangers Subsystems

Number of Units: (13 subsystems were included in the base and equipment prices below)

Design Data:

Size
Duty
Etc. (Temp./Press)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : $\$1.475 \times 10^6$

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_P
Size	F_{Mag}

Purchased Equipment Cost E [$E = B \times (F_M \times F_T \times F_P \times F_{Mag})$] $\$E \ 5.809 \times 10^6$

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.848 of B	\$M	1.251 x 10 ⁶
Total Direct Material (E+M)		<u>\$(E+M)</u>	<u>7.06</u> x 10 ⁶
Labor Component (L) % x B	.644 of B	\$L	<u>.95</u> x 10 ⁶
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	8.01 x 10 ⁶
Indirect Construction Costs	.36 of (E+M+L)		<u>2.884</u> x 10 ⁶
			\$10.894 x 10 ⁶
Escalation to January 1980 dollars	1.14		
TOTAL MODULE COST, EQUIPMENT			\$12.419 x 10 ⁶

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TEXACO/SNG

SUBSYSTEM COST DATA

3 - Initial Gas Clean-up & Cooling

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 3-V-1 through 5

Category: Vertical Vessels Subsystems

Number of Units (5 vertical vessels are included in prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$87,500

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E [$E = B \times (F_M \times F_T \times F_p \times F_{Mag})$] \$E 282,000

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.761 of B	\$M	66,588
Total Direct Material (E+M)		<u>\$(E+M)</u>	<u>348,588</u>
Labor Component (L) % x B	.632 of B	\$L	<u>55,300</u>
Subtotal Installed Equipment (E+M+L)		<u>\$(E+M+L)</u>	<u>403,888</u>
Indirect Construction Costs	.36 of (E+M+L)		<u>145,400</u>
			<u>\$549,288</u>
Escalation to January 1980 dollars	1.14		
TOTAL MODULE COST, EQUIPMENT			$\$0.626 \times 10^6$

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TEXACO/SNG

SUBSYSTEM COST DATA

3 - Initial Gas Clean-up & Cooling

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 13-P-1 through 3

Category: Centrifugal Pumps & Motor Subsystems

Number of Units: (9 pumps are included in costs below)

Design Data:

Size
Duty
Etc. (Temp./Press)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$54,000

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E $[(E = B \times (F_M \times F_T \times F_p \times F_{Mag}))]$ \$E 126,000

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.751 of B	\$M	40,554
Total Direct Material (E+M)		<u>\$(E+M)</u>	<u>166,554</u>
Labor Component (L) % x B	.71 of B	\$L	<u>38,340</u>
Subtotal Installed Equipment (E+M+L)		<u>\$(E+M+L)</u>	<u>204,894</u>
Indirect Construction Costs	.36 of (E+M+L)		<u>73,762</u>
			<u>\$278,656</u>
Escalation to January 1980 dollars	1.14		
TOTAL MODULE COST, EQUIPMENT			$\$0.318 \times 10^6$

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TEXACO/SNG

SUBSYSTEM COST DATA

3 - Initial Gas Clean-up & Cooling

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 3-ME-1

Category: Gas Scrubbing Subsystem

Number of Units: 1

Design Data:

Size
Duty
Etc. (Temp./Press)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$65,000

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E $[(E = B \times (F_M \times F_T \times F_p \times F_{Mag}))]$ \$E 200,000

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.761 of B	\$M	49,465
Total Direct Material (E+M)		<u>\$ (E+M)</u>	<u>249,465</u>
Labor Component (L) % x B	.632 of B	\$L	<u>41,080</u>
Subtotal Installed Equipment (E+M+L)		<u>\$ (E+M+L)</u>	<u>290,545</u>
Indirect Construction Costs	.36 of (E+M+L)		<u>104,596</u>
			<u>\$395,141</u>
Escalation to January 1980 dollars	1.14		
TOTAL MODULE COST, EQUIPMENT			\$450,460

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

TEXACO/SNG PROCESS, SYSTEM NO. 3, INITIAL GAS CLEAN-UP AND COOLING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>MBG MODULE 3</u>	<u>MBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
SUBSYSTEM NO. HEAT EXCHANGERS	\$12.419	\$12.419	\$12.419
SUBSYSTEM NO. VERTICAL VESSELS	.626	.626	.626
SUBSYSTEM NO. CENTRIFUGAL PUMPS	.318	.318	.318
SUBSYSTEM NO. GAS SCRUBBER	.450	.450	.450
<u>SUBTOTAL:</u>	13.813	13.813	13.813
TOTAL PROCESS CONTINGENCY: 0%			
<u>SUBTOTAL:</u>	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$13.813	\$13.813	\$13.813

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SYSTEM COST DATA

PROCESS: TEXACO/SNG
SYSTEM: 4-ACID GAS REMOVAL RECTISOL
UNIT OPERATION NUMBER: 22
REFERENCE SOURCE: CF BRAUN FE-2240-31
REFERENCE SYSTEM COST: $\$32.27 \times 10^6$ (1977 DOLLARS)
REFERENCE CAPACITY: 13,827 LB MOLE/HR
TVA CAPACITY: 14,667 LB MOLE/HR
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS:
COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST \times CAPACITY FACTOR \times ESCALATION FACTOR

CAPACITY FACTOR: $\left(\frac{\text{TVA LB MOLE/HR}}{\text{REF LB MOLE/HR}} \right)^{0.6}$

INPUTS:

REFERENCE COST: $\$32.27 \times 10^6$ (1977 DOLLARS)

CAPACITY FACTOR: $\left(\frac{14,667}{13,827} \right)^{0.6} = 1.036$

ESCALATION FACTOR: 1.22 (TO JANUARY 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$40.787 \times 10^6$ (JANUARY 1980 DOLLARS)

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 4, ACID GAS REMOVAL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>MBG MODULE 3</u>	<u>MBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS RECTISOL UNIT			
<u>SUBTOTAL:</u>	\$40.787	\$40.787	\$40.787
TOTAL PROCESS CONTINGENCY: 5%			
<u>SUBTOTAL:</u>	2.039	2.039	2.039
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$42.826	\$42.826	\$42.826

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 5 - SULFUR RECOVERY & TAILGAS TREATMENT

SUBSYSTEM: N/A

UNIT OPERATION NUMBER: 36

REFERENCE SOURCE: DOE REPORT FE-1775-18, PLANT 2

REFERENCE SYSTEM COST: \$9,032,000 MID-1977 DOLLARS

REFERENCE CAPACITY: 181.2 LT/D SULFUR PRODUCT

TVA CAPACITY: 165.2 LT/D SULFUR PRODUCT

RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS:

1. PROCESS NOTE: NORMAL OPERATING RATE OF PLANT 2 IS 240 M/H FEED ALTHOUGH DESIGN IS 527.5 M/H
2. PROVIDE 1 TRAIN FOR EACH TEXACO MODULE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST x INDIRECT CONSTRUCTION COSTS x CAPACITY FACTOR x ESCALATION FACTOR

CAPACITY FACTOR = $\left(\frac{\text{TVA CAP}}{\text{REF CAP}} \right)^{0.6}$

INPUTS:

REFERENCE SYSTEM COST: $\$9.032 \times 10^6$ (MID-1977 DOLLARS)

INDIRECT CONSTRUCTION COSTS: 1.10
(I.E. ENGINEERING AND HOME OFFICE)

CAPACITY FACTOR: $\left(\frac{165.2}{181.2} \right)^{0.6} = .946$

ESCALATION FACTOR: 1.22 (FROM MID-77 TO JANUARY 1980 DOLLARS)

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THE BDM CORPORATION

RESULTS:

TOTAL SYSTEM COSTS = $\$11.466 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 5, SULFUR RECOVERY AND TAILGAS TREATMENT

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>MBG MODULE 3</u>	<u>MBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
	11.466	11.466	11.466
<u>SUBTOTAL:</u>			
	1.720	1.720	1.720
TOTAL PROCESS CONTINGENCY: 15%	\$13.186	\$13.186	\$13.186
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>			

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 6 - AIR SEPARATION

UNIT OPERATION NUMBER: 80

REFERENCE SOURCE: MITTELHAUSER INTERNAL COST DATA REPRESENTING A "COMPOSITE" OXYGEN PLANT BASED ON SEVERAL VENDORS, PLUS THE NECESSARY COMPRESSION COSTS (REFER TO ENCLOSED COST CURVES)

REFERENCE SYSTEM COST: \$36 X 10⁶ PER UNIT (10 REQUIRED)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 5 @ 1657 TPD OXYGEN (100%) PER UNIT @ 814.7 PSIA O₂

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

- (1) MODULES 2 AND 4 REQUIRE 3 UNITS EACH
- (2) MODULE 3 REQUIRES 2 UNITS

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE UNIT COST x NO. OF UNITS

INPUTS:

TOTAL INSTALLED COST = \$36,000,000 PER UNIT (JANUARY 1980 DOLLARS)

RESULTS:

MODULES 2 AND 4 = \$108.0 X 10⁶ (JANUARY 1980 DOLLARS)

MODULE 3 = \$72.0 X 10⁶ (JANUARY 1980 DOLLARS)

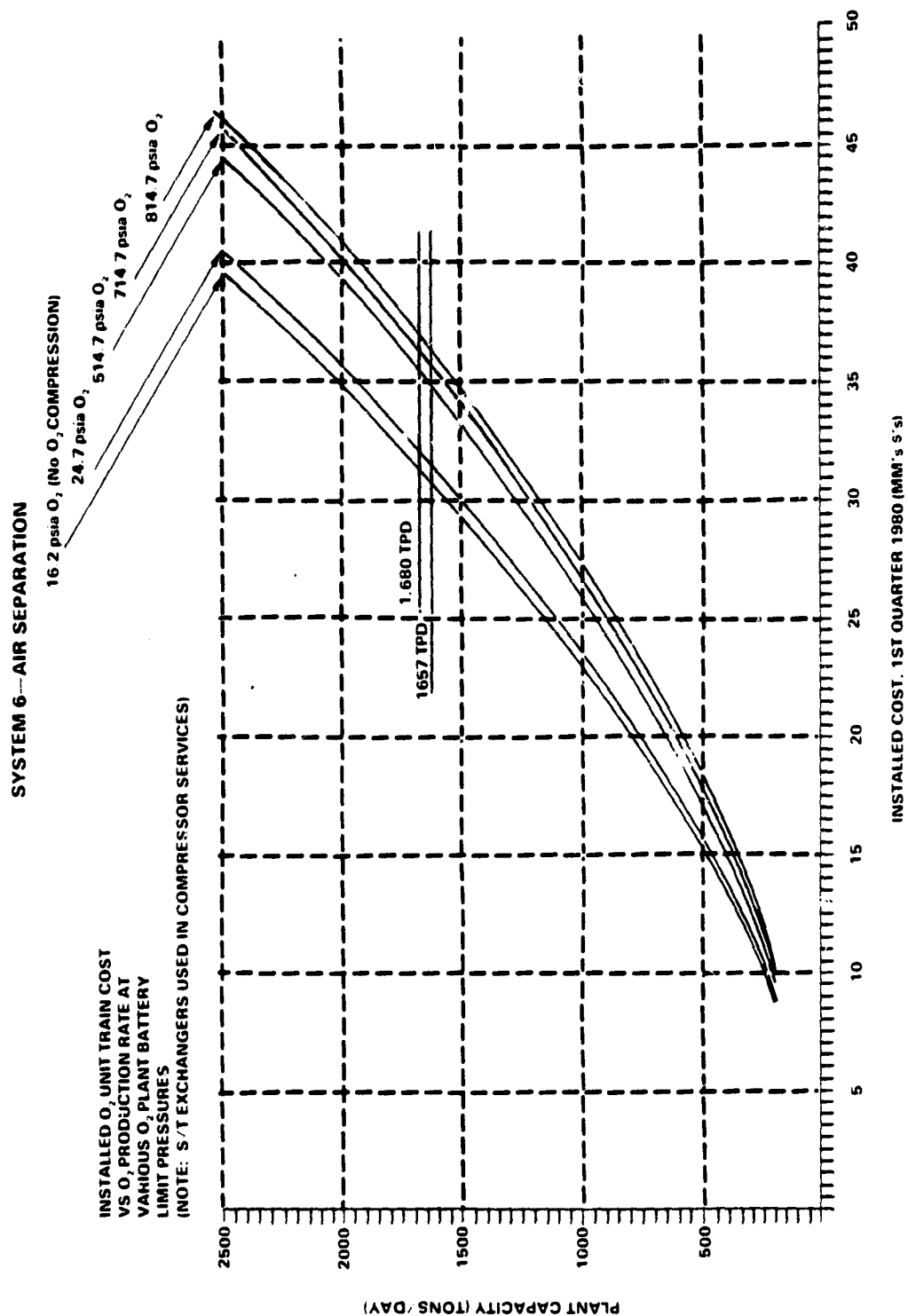


Figure III-2. Air Separation Plant Installed Cost for the Texaco/SNG Process

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 6, AIR SEPARATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>MBG MODULE 3</u>	<u>MBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
<u>SUBTOTAL:</u>	\$108	\$ 72	\$108
TOTAL PROCESS CONTINGENCY: 0%			
<u>SUBTOTAL:</u>	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$108	\$ 72	\$108

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	TEXACO/SNG
<u>SYSTEM:</u>	7 - COMPRESSION
<u>UNIT OPERATION:</u>	N/A
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	N/A
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	

SYSTEM NOT REQUIRED FOR THIS PROCESS DESIGN

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 8 - PROCESS SOLIDS TREATMENT (DEWATERING)

SUBSYSTEM: GASIFIER SLAG HANDLING

UNIT OPERATION NUMBER: 80

REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE

REFERENCE SYSTEM COST: \$513,000 JANUARY 1980 DOLLARS (TOTAL DIRECT COSTS)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 61,167 #/HR

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THIS SUBSYSTEM DOES NOT REQUIRE THE SAME EQUIPMENT AS THE KOPPERS-TOTZEK PROCESS.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS = \$513,000 (JANUARY 1980 DOLLARS)

INDIRECT COST FACTOR: 0.335 (ASSUME .25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SYSTEM COST = \$684,855 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 8 - PROCESS SOLIDS TREATMENT (DEWATERING)

SUBSYSTEM: WATER TREATMENT SLUDGE HANDLING

UNIT OPERATION NUMBER: 31

REFERENCE SOURCE FOR COSTING: MITTELHAUSER IN-HOUSE COST DATA BASE

REFERENCE SYSTEM COST: \$30,000 JANUARY 1980 DOLLARS (TOTAL DIRECT COSTS) (SEE BELOW)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 1320 GAL/DAY OF 15% BY WEIGHT SLUDGE

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS:	2 LINED PONDS FOR GRAVITY DEWATERING	\$24,000
	25% CONTINGENCY FOR PUMPS	6,000
	TOTAL	<u>\$30,000</u>
	(JANUARY 1980 DOLLARS)	

INDIRECT COST FACTOR: 0.335 (ASSUME .25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SYSTEM COST = \$40,050 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

TEXACO/SNG PROCESS, SYSTEM NO. 8, PROCESS SOLIDS TREATMENT (DEWATERING)

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>MBG MODULE 3</u>	<u>MBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
SUBSYSTEM: GASIFIER SLAG HANDLING	\$.685	\$.685	\$.685
SUBSYSTEM: WATER TREATMENT	.940	.040	.040
SLUDGE HANDLING	.725	.725	.725
<u>SUBTOTAL:</u>			
TOTAL PROCESS CONTINGENCY 0%	-0-	-0-	-0-
<u>SUBTOTAL:</u>			
TOTAL SYSTEM CAPITAL INVESTMENT:	\$.725	\$.725	\$.725

THE BDM CORPORATION

SYSTEM COST DATA

<u>PROCESS:</u>	TEXACO/SNG
<u>SYSTEM:</u>	9 - INCINERATION
<u>SUBSYSTEM:</u>	N/A
<u>UNIT OPERATION NUMBER:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	N/A
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	

SYSTEM NOT APPLICABLE TO PROCESS DESIGN

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 10 - INSTRUMENTATION AND CONTROL

UNIT OPERATION NUMBER: N/A

REFERENCE SOURCE: GENERAL ELECTRIC ESTIMATE

REFERENCE SYSTEM COST: $\$1.5 \times 10^6$ JANUARY 1980 DOLLARS
(EQUIPMENT COST)

REFERENCE CAPACITY: REFERENCE COST BASED UPON A HONEYWELL
4500 SYSTEM

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THE SYSTEM CONTAINS JUST THE NECESSARY INSTRUMENTATION FOR THE CENTRALIZED REMOTE FACILITY. IT CONTAINS SUFFICIENT CABLE TO TRANSMIT SIGNALS FROM THE PROCESS UNITS? DATA PROCESSING EQUIPMENT, SOFTWARE PACKAGES FOR THE ANALYSIS OF INCOMING DATA, AND DISPLAY PANELS FOR PRESENTATION OF DATA. THIS SYSTEM DOES NOT INCLUDE LOCAL CONTROLS FOR DIRECT OPERATION OF INDIVIDUAL SYSTEMS.

COMPUTATION METHOD:

TOTAL DIRECT COST = $(1 + \text{INSTALLATION FACTOR}) \times \text{REFERENCE EQUIPMENT COST}$

TOTAL SYSTEM COST = $\text{TOTAL DIRECT COST} \times (1 + \text{INDIRECT COST FACTOR})$

INPUTS:

REFERENCE COST: $\$1.5 \times 10^6$ (JANUARY 1980 DOLLARS)

INSTALLATION FACTOR: 1.10 (ASSUMED)

INDIRECT COST FACTOR: 0.289 (90/10 ASSUMED M/L RATIO)

RESULTS:

TOTAL DIRECT COSTS = $\$3.15 \times 10^6$ (JANUARY 1980 DOLLARS)

TOTAL SYSTEM COST = $\$4.06 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 10, INSTRUMENTATION AND CONTROL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>MBG MODULE 3</u>	<u>MBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
	\$4.06	\$4.06	\$4.06
<u>SUBTOTAL:</u>			
TOTAL PROCESS CONTINGENCY: 15%			
	\$0.609	\$0.609	\$0.609
<u>SUBTOTAL:</u>			
TOTAL SYSTEM CAPITAL INVESTMENT:	\$4.669	\$4.669	\$4.669

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SYSTEM COST DATA

<u>PROCESS:</u>	TEXACO/SNG
<u>SYSTEM:</u>	11 - COAL HANDLING
<u>UNIT OPERATION:</u>	10
<u>SUBSYSTEM:</u>	N/A
<u>REFERENCE SOURCE FOR COSTING:</u>	N/A
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A

EXPLANATORY COMMENTS:

COAL HANDLING IS INCLUDED UNDER LISTING OF GENERAL FACILITIES SYSTEMS SINCE IT IS DESIGNED TO SERVE ALL FOUR MODULES.

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 12 - SOLIDS WASTE RECYCLING/DISPOSAL

UNIT OPERATION NUMBER: 81

REFERENCE SOURCE: MITTELHAUSER ESTIMATE (FROM IN-HOUSE COST DATA BASE)

REFERENCE SYSTEM COST: $\$16.1 \times 10^6$ (JANUARY 1980 DOLLARS) (TOTAL DIRECT COSTS - SEE BELOW)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 61,000 #/HR SOLIDS (DRY), 2319 GAL/HR H₂O WITH SOLIDS

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. SYSTEM IS ESSENTIALLY AN EXCAVATED AREA FOR 20 YEARS OF SOLID DISPOSAL. INCLUDES EXCAVATION AND CONSTRUCT OF CLAY-LINED DISPOSAL AREA RUNOFF-HOLDING POND.
2. LAND COSTS WERE NOT INCLUDED

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COST =

INSTALLED COST OF SOLIDS DISPOSAL AREA =	$\$10.0 \times 10^6$
INSTALLED COST OF RUNOFF COLLECTION BASIN =	6.1×10^6
(BOTH ARE LINED WITH CLAY LINER)	$\$16.1 \times 10^6$

INDIRECT COST FACTOR: 0.335 (ASSUMED .25 L/M RATIO FOR SOLIDS HANDLING)

RESULTS:

TOTAL SYSTEM COST = $\$21.494 \times 10^6$ (JANUARY 1980 DOLLARS)

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THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

TEXACO/SNG PROCESS SYSTEM NO. 12, SOLIDS WASTE RECYCLING/DISPOSAL

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>MBG MODULE 3</u>	<u>MBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
SUBSYSTEM: LINED DISPOSAL AREA	\$13.350	\$13.350	\$13.350
SUBSYSTEM: RUNOFF COLLECTION	8.144	8.144	8.144

SUBTOTAL:

21.494 21.494 21.494

TOTAL PROCESS CONTINGENCY: 0%

SUBTOTAL:

-0- -0- -0-

TOTAL SYSTEM CAPITAL INVESTMENT:

\$21.494 \$21.494 \$21.494

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 13 - BYPRODUCTS PROCESSING

SUBSYSTEM: SULFUR STORAGE AND LOADING

UNIT OPERATION NUMBER: 83

REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST DATA BASE

REFERENCE SYSTEM COST: $\$1 \times 10^6$ (JANUARY 1980 DOLLARS)

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. ORDER OF MAGNITUDE ESTIMATE OF $\$1 \times 10^6$ BASED UPON FLAKING SULFUR STORAGE FACILITY RATHER THAN PRILL TOWER.

COMPUTATION METHOD: N/A

INPUTS:

REFERENCE SYSTEM COST = $\$1 \times 10^6$ (JANUARY 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$1 \times 10^6$ (JANUARY 1980 DOLLARS FOR EACH MODULE)

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 13, BYPRODUCT PROCESSING

SYSTEM CAPITAL INVESTMENT TABLE

ITEM DESCRIPTION	SNG MODULE 2	MBG MODULE 3	MBG MODULE 4
TOTAL DIRECT PLUS INDIRECT COSTS	\$1	\$1	\$1
<u>SUBTOTAL:</u>	-0-	-0-	-0-
TOTAL PROCESS CONTINGENCY: 0%	\$1	\$1	\$1
<u>SUBTOTAL:</u>			
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>			

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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 14 - PLANT POWER SYSTEM

SUBSYSTEM: TURBOGENERATOR FOR ON-SITE POWER FOR
I.P. STEAM

UNIT OPERATION NUMBER: 87

REFERENCE SOURCE: EQUIPMENT-FACTORED COST ESTIMATE FROM
GUTHRIE, PROCESS PLANT ESTIMATING,
EVALUATION AND CONTROL

REFERENCE SYSTEM COST: \$17,040,000 MID-1978 DOLLARS (EQUIPMENT
COST)

REFERENCE CAPACITY: 38,500 KW

TVA CAPACITY: 38,500 KW

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

MITTELHAUSER ESTIMATE FROM IN-HOUSE COST DATABASE AS WELL AS
GUTHRIE, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL.

COMPUTATION METHOD:

TOTAL SYSTEM COST = EQUIPMENT COST x INSTALLATION FACTOR x
(1 + INDIRECT COST FACTOR) x ESCALATION
FACTOR

INPUTS:

EQUIPMENT COST: "POWER GENERATION FACILITY"
FOR 38,500 KW = \$22,560,000
MINUS
"FIELD ERECTED BOILER
COST" FOR 666,000 LB/HR
STEAM = 5,600,000
ESTIMATED EQUIPMENT COST \$17,040,000
(MID-1978
DOLLARS)

INSTALLATION FACTOR: 1.307

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INDIRECT COST FACTOR: 0.15 (ASSUMED)

ESCALATION FACTOR: 1.14 (FROM 1978 TO 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$29.198 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 14 - PLANT POWER SYSTEM

SUBSYSTEM: PLANT ELECTRICAL DISTRIBUTION

UNIT OPERATION NUMBER: 87

REFERENCE SOURCE: REQUIREMENTS FACTORED COST ESTIMATE FROM GUTHRIE, PROCESS PLANT ESTIMATING, EVALUATION AND CONTROL, p. 363.

REFERENCE SYSTEM COST: \$102.62 (1970 DOLLARS/KILOWATT) (FACTOR FOR ELECTRICAL DISTRIBUTION FIELD INSTALLATION COSTS IN NORMAL RANGE)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 88,000 KW

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = KILOWATT REQUIREMENT x TOTAL DIRECT COST FACTOR x (1 + INDIRECT COST FACTOR) x ESCALATION FACTOR

INPUTS:

KILOWATT REQUIREMENT (INCLUDING IMPORT AND INTERNAL GENERATION) = 88,000 KW

TOTAL DIRECT COST FACTOR = \$102.62 (1970 DOLLARS/PER KILOWATT)

INDIRECT COST FACTOR = 0.469 (BASED ON 0.72 L/M RATIO)

ESCALATION FACTOR = 1.988 (FROM 1970 BASE YEAR DOLLARS)

RESULTS:

TOTAL SYSTEM COST = \$26.373 x 10⁶ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 14, PLANT POWER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>HBG MODULE 3</u>	<u>HBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
SUBSYSTEM: TURBO GENERATOR	\$29.198	\$29.198	\$29.198
SUBSYSTEM: DISTRIBUTION	26.373	26.373	26.373
<u>SUBTOTAL:</u>	55.571	55.571	55.571
TOTAL PROCESS CONTINGENCY: 0%			
<u>SUBTOTAL:</u>	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$55.571	\$55.571	\$55.571

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG
SYSTEM: 15 - STEAM GENERATION/DISTRIBUTION
UNIT OPERATION NUMBER: 86
REFERENCE SOURCE FOR COSTING: REQUIREMENTS FACTORED COST FROM GUTHRIE,
PROCESS PLANT ESTIMATING, EVALUATION AND
CONTROL, p. 365.

REFERENCE SYSTEM COST:

TOTAL DIRECT COST FACTOR = 1.68 (1970 DOLLARS PER LBS PER HR)

REFERENCE CAPACITY: N/A

TVA CAPACITY: STEAM REQUIREMENT = 1,686,500 LBS/HR
(FOR MODULE 2)
STEAM REQUIREMENT = 1,086,500 LBS/HR
(FOR MODULES 3 AND 4)

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

1. THIS SYSTEM ONLY CONTAINS EQUIPMENT FOR THE GENERAL DISTRIBUTION OF BOILER FEED WATER, COLLECTION OF CONDENSATE, DEAERATION OF CONDENSATE, AND MINIMAL SURGE STORAGE OF DEMINERALIZED WATER.
2. THE STEAM REQUIREMENT HAS BEEN INCREASED OVER THE BASE CASE TO PROVIDE A CONTINGENCY TO COVER THE STEAM REQUIREMENTS IN THE ALTERNATE PRODUCTS CASE.

COMPUTATION METHOD:

TOTAL SYSTEM COST = STEAM REQUIREMENT x TOTAL DIRECT COST
FACTOR x (1 + INDIRECT COST FACTOR) x
ESCALATION FACTOR

INPUTS:

STEAM REQUIREMENT = 1,686,500 LBS/HR (FOR MODULE 2)
1,086,500 LBS/HR (FOR MODULES 3 AND 4)

TOTAL DIRECT COST FACTOR = \$1.68 (1970 DOLLARS PER LBS/HR)

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INDIRECT COST FACTOR =

0.488 (BASED ON .82 L/M RATIO)

ESCALATION FACTOR =

1.988 (BASED ON JANUARY 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST (FOR
MODULE 2) =

$\$8.381 \times 10^6$ (JANUARY 1980 DOLLARS)

TOTAL SYSTEM COST (FOR
MODULES 3 AND 4) =

$\$5.340 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 15, STEAM GENERATION/DISTRIBUTION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>HBG MODULE 3</u>	<u>HBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
<u>SUBTOTAL:</u>	\$8.381	\$5.340	\$5.340
TOTAL PROCESS CONTINGENCY: 0%			
<u>SUBTOTAL:</u>	-0-	-0-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$8.381	\$5.340	\$5.340

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG
SYSTEM: 16 - WATER SUPPLY
SUBSYSTEM: RAW WATER TREATMENT
UNIT OPERATION NUMBER: 85
REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST DATA BASE
REFERENCE SYSTEM COST: \$758,000 JANUARY 1980 DOLLARS (TOTAL DIRECT COST)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 2533 GPM
RECOMMENDED CAPACITY EXPONENT: N/A
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS =	FIRE WATER POND	\$164,000
	CLARIFIER	503,000
	CHEMICAL FEED SYSTEM	91,000
	TOTAL DIRECT COSTS	<u>\$758,000</u>
	(JANUARY 1980 DOLLARS)	

INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = $\$1.031 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 16 - WATER SUPPLY

UNIT OPERATION NUMBER: 85

SUBSYSTEM: BOILER FEED WATER TREATMENT

REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST DATA BASE

REFERENCE SYSTEM COST: \$918,000 JANUARY 1980 DOLLARS (TOTAL DIRECT COSTS) - SEE BELOW

REFERENCE CAPACITY: N/A

TVA CAPACITY: 50 GPM

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS:	1. FILTER	\$ 47,000
	2. PARALLEL, SKID-MOUNTED	
	3. DEMINERALIZER TRAINS	833,000
	4. CHEMICAL STORAGE TANKS	38,000
	TOTAL DIRECT COSTS	\$918,000
		(JANUARY 1980 DOLLARS)

INDIRECT COST FACTOR = 0.36 (75/25 ASSUMED "NORMAL" M/L RATIO)

RESULTS:

TOTAL SYSTEM COST = \$1.248 x 10⁶ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 16, WATER SUPPLY

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>MBG MODULE 3</u>	<u>MBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
SUBSYSTEM NO. RAW WATER TREATMENT	\$1.031	\$1.031	\$1.031
SUBSYSTEM NO. BOILER FEED WATER TREATMENT	1.248 2.279	1.248 2.279	1.248 2.279
<u>SUBTOTAL:</u>			
TOTAL PROCESS CONTINGENCY: 0%	-0-	-0-	-0-
<u>SUBTOTAL:</u>			
TOTAL SYSTEM CAPITAL INVESTMENT:	\$2.279	\$2.279	\$2.279

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SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 17 - COOLING WATER SYSTEM

UNIT OPERATION NUMBER: 39

SUBSYSTEM: UTILITY COOLING TOWER

REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST ESTIMATE

REFERENCE SYSTEM COST: \$4,200,000 JANUARY 1980 DOLLARS (TOTAL DIRECT COSTS)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 80,500 GPM

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS: 4.2×10^6 (JANUARY 1980 DOLLARS)

INDIRECT COST FACTOR: 0.36 (ASSUME .25 L/M RATIO FOR MIXED PROCESSES)

RESULTS:

TOTAL SUBSYSTEM COSTS = \$5,712,000 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG
SYSTEM: 17 - COOLING WATER SYSTEM
UNIT OPERATION NUMBER: 39
SUBSYSTEM: BLOWDOWN TREATMENT
REFERENCE SOURCE: MITTELHAUSER IN-HOUSE COST ESTIMATE
REFERENCE SYSTEM COST: \$852,000 JANUARY 1980 DOLLARS (TOTAL DIRECT COSTS)
REFERENCE CAPACITY: N/A
TVA CAPACITY: 42 GPM
RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

SUBSYSTEM IS A VAPOR COMPRESSION EVAPORATOR.

COMPUTATION METHOD:

TOTAL SUBSYSTEM COST = TOTAL DIRECT COSTS \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COSTS: \$852,000 (JANUARY 1980 DOLLARS)
INDIRECT COST FACTOR: 0.36 (ASSUME .25 L/M RATIO FOR MIXED PROCESSES)

RESULTS:

TOTAL SUBSYSTEM COST = \$1,158,720 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 17, COOLING WATER SYSTEM

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 2</u>	<u>MBG MODULE 3</u>	<u>MBG MODULE 4</u>
TOTAL DIRECT PLUS INDIRECT COSTS			
SUBSYSTEM: COOLING TOWER	\$5.712	\$5.712	\$5.712
SUBSYSTEM: BLOWDOWN TREATMENT	1.159	1.159	1.159
<u>SUBTOTAL:</u>	6.871	6.871	6.871
 TOTAL PROCESS CONTINGENCY: 0%			
<u>SUBTOTAL:</u>	-0-	-0-	-0-
 <u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	 \$6.871	 \$6.871	 \$6.871

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 18 - WASTE WATER TREATMENT

SUBSYSTEM: PROCESS CONDENSATE TREATMENT

UNIT OPERATION NUMBER: 37

REFERENCE SOURCE: EPA 600/2-78-182

REFERENCE SYSTEM COST: \$28,000 (JANUARY 1980 DOLLARS)

REFERENCE CAPACITY: N/A

TVA CAPACITY: 50 GPM

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST x (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COST: \$28,000 (JANUARY 1980 DOLLARS)

CONSISTS OF: PRESSURE LEAF FILTER
CHEMICAL CLEANER
PUMPS

INDIRECT COST FACTOR: 0.37 (ASSUME .365 L/M RATIO FOR CHEMICAL PROCESSES)

RESULTS:

TOTAL SYSTEM COST = \$38,360 (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
 TEXACO/SNG PROCESS, SYSTEM NO. 18, WASTE WATER TREATMENT

SYSTEM CAPITAL INVESTMENT TABLE

MBG
MODULE
4

MBG
MODULE
3

SNG
MODULE
2

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

SUBTOTAL:

TOTAL PROCESS CONTINGENCY: 0%

SUBTOTAL:

TOTAL SYSTEM CAPITAL INVESTMENT:

\$0.038

\$0.038

\$0.038

-0-

-0-

-0-

\$0.038

\$0.038

\$0.038

THE BDM CORPORATION

c. General Facilities Systems Costs Supporting Modules I-IV

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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: K-T/TEXACO - METHANE/SNG

SYSTEM: 11-COAL HANDLING

UNIT OPERATION NUMBER: 10

SUBSYSTEM: N/A

REFERENCE SOURCE FOR COSTING: EQUIPMENT FACTORED COST ESTIMATE BY
RESOURCE ENGINEERING, INC. BASED ON
VENDOR QUOTES AND HISTORIC DATA. SEE
DETAILED EQUIPMENT LISTING WHICH FOLLOWS.

REFERENCE SYSTEM COST: \$48,100,000 JANUARY 1980 DOLLARS (TOTAL
DIRECT COSTS)

REFERENCE CAPACITY: 920,000 TONS OF COAL PER DAY

TVA CAPACITY: 20,000 TONS OF COAL PER DAY

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

THIS SYSTEMS IS SIZED TO SERVE THE NEEDS OF ALL FOUR MODULES TO BE
BUILT IN THE FACILITY.

COMPUTATION METHOD:

TOTAL SYSTEM COST = TOTAL DIRECT COST \times (1 + INDIRECT COST FACTOR)

INPUTS:

TOTAL DIRECT COST = \$48,100,000 (JANUARY 1980 DOLLARS)
INDIRECT COST FACTOR = 0.335 (80/20 ASSUMED M/L RATIO FOR SOLIDS-
HANDLING SYSTEMS)

RESULTS:

TOTAL SYSTEM COST = \$64.214 $\times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

SYSTEM 11

COAL HANDLING

(EQUIPMENT FACTORED COSTS)

<u>DESCRIPTION</u>	<u>JANUARY 1980 IN MILLION DOLLARS (10⁶)</u>
1. Continuous barge unloader, elevator type, 3,000-3,500 TPH, including dock, moorings, surge bin, conveyors	\$ 10.0
2. Open coal storage piles, 1.8 x 10 ⁶ tons Double windows 100' high x (2 x 240') wide x 2,800' Costs for site preparation, stock- piling conveyors, stacker/reclaiming equip- ment, mobile equipment	30.0
3. Rotary brakers, three (2N, 1S), 1,000 TPH each 50 hp each, 12' ϕ x 22' each	1.0
4. Concrete silos, four, 11,750 tons each, 67' ϕ x 150' each	6.0
5. Truck dump hopper, 2,000 tons	0.2
6. Conveyors not included above	
a. Truck station to crusher, 500 TPH 36" x 500 ft., 0 elevation, 426 fpm, 32 hp	0.3
b. Crusher to silos, 2,160 TPH 60" x 700 ft., 150 ft. elevation, 470 hp, 600 fpm	<u>0.6</u>
TOTAL DIRECT COSTS (E+M+L) =	\$ 48.1

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK/TEXACO/SNG PROCESS, SYSTEM NO. 11, COAL HANDLING

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>GENERAL FACILITIES</u>
TOTAL DIRECT PLUS INDIRECT COSTS <u>SUBTOTAL:</u>	\$ 64.214
TOTAL PROCESS CONTINGENCY: 0% <u>SUBTOTAL:</u>	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 64.214

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/TEXACO - METHANE/SNG

SYSTEM: 19 - GENERAL FACILITIES (BLDG & SUPPORT)

UNIT OPERATION NUMBER: 88

REFERENCE SOURCE FOR COSTING: EVALUATION OF INTERMEDIATE - BTU COAL GASIFICATION SYSTEMS FOR RETROFITTING POWER PLANTS, EPRI AF-531, AUGUST 1977

REFERENCE SUBSYSTEM COST: SEE BELOW

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

INVESTMENT FOR SERVICE FACILITIES SUCH AS MAINTENANCE SHOPS, STORES, COMMUNICATIONS, SECURITY, AND OFFICES IS ESTIMATED AT 4.9% OF DIRECT INVESTMENT. THIS ESTIMATE WAS PREPARED BY TVA BASED ON ITS CONSTRUCTION EXPERIENCE.

COMPUTATION METHOD:

- TOTAL SYSTEM COST = TOTAL DIRECT SYSTEM INVESTMENTS \times (.049)
- where
1. TOTAL DIRECT COSTS = TOTAL SYSTEM CAPITAL INVESTMENT-INDIRECT COSTS
 2. = TSCI - TDSI \times INDIRECT COST FACTOR
 3. = $\frac{1}{(1 + \text{INDIRECT COST FACTOR})} \times \text{TSCI}$

INPUTS:

INDIRECT COST FACTOR: 0.36 (ASSUMED "NORMAL" L/M RATIO)
SUBTOTAL FOR TOTAL SYSTEM CAPITAL INVESTMENT = $\$1297.278 \times 10^6$
(JANUARY 1980 DOLLARS) (EXCLUDING BUILDING & SUPPORT)

RESULTS:

TOTAL DIRECT COSTS = $\$953.881 \times 10^6$

TOTAL SYSTEM COST = $\$46.740 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK/TEXACO - METHANE/SNG PROCESS, SYSTEM NO. 19, GENERAL FACILITIES (BLDG & SUPPORT)

SYSTEM CAPITAL INVESTMENT TABLE

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS
SUBTOTAL:

\$ 46.740

TOTAL PROCESS CONTINGENCY: 0%
SUBTOTAL:

-0-

TOTAL SYSTEM CAPITAL INVESTMENT

\$ 46.740

GENERAL FACILITIES

THE BDM CORPORATION

- d. **Koppers - Totzek/SNG and Texaco/SNG Alternate Products Systems Costs**

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THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS - TOTZEK/SNG

SYSTEM: 20A - ALTERNATE PRODUCTS/CO SHIFT

UNIT OPERATION NUMBER: 90 - SHIFT CONVERSION

SUBSYSTEMS: HEAT EXCHANGES
VESSELS
PUMPS & MOTORS

REFERENCE SOURCE FOR COSTING: GUTHRIE, PROCESS PLANT, ESTIMATING,
EVALUATION AND CONTROL

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: (1) SEE FOLLOWING PAGES FOR A LISTING
OF ALL THE EQUIPMENT COSTS (MID-1978
DOLLARS).

(2) THE K-T/SNG ALTERNATE PRODUCTS
CO-SHIFT SYSTEM WAS DESIGNED AT
THE EQUIPMENT LEVEL AND EACH
MAJOR EQUIPMENT ITEM PRICED BASED
UPON GUTHRIE.

COMPUTATION METHOD: N/A

INPUTS: N/A

RESULTS:

TOTAL SYSTEM COST = \$2.949 x 10⁶ (JANUARY 1980 DOLLARS)

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THE BDM CORPORATION

KIPPERS-TOTZEK/SNG

SYSTEM COST DATA

20A - CO SHIFT SYSTEM

<u>Item</u>	<u>Type</u>	(B) (Mid-1978) Base <u>Equipment</u> <u>Cost-Each</u>	(E) (Mid-1978) <u>Equipment</u> <u>Cost-Each</u>	<u>Number</u> <u>Required</u>
90-E-1	Shell & Tube Heat Exgr.	\$ 52,900	\$ 85,700	1
90-E-2	Shell & Tube Heat Exgr.	54,900	85,600	1
90-E-3	Shell & Tube Heat Exgr.	15,700	24,900	1
90-E-4	Shell & Tube Heat Exgr.	80,350	124,630	4
90-E-5	Shell & Tube Heat Exgr.	35,300	39,500	1
90-E-6	Shell & Tube Heat Exgr.	22,500	20,700	1
90-E-7	Shell & Tube Heat Exgr.	12,700	14,000	1
90-EA-1	Air-Cooled Heat Exgr.	21,600	25,300	1
90-EA-2	Air-Cooled Heat Exgr.	9,800	11,500	1
90-RX-1	CO Shift Reactor Vessel	22,000	50,600	1
90-RX-2	COS Hydrolysis Reactor Vessel	8,100	18,600	1
90-V-1	Shift Condensate Vessel	11,500	36,000	1
90-V-2	Hydrodysis Condensate Vessel	1,600	5,200	1
90-P-1	Centrifugal Pump & Motor	12,000	20,700	2
90-P-2	Centrifugal Pump & Motor	2,100	3,300	2

THE BDM CORPORATION

KOPPERS-TOTZEK/SNG

SUBSYSTEM COST DATA

20A - CO SHIFT SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 90-E-1 to E-7 AND 90-EA-1 to 90-EA-2.

Category: Heat Exchangers Subsystems

Number of Units: (12 subsystems were included on the base and equipment price below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$.5468 x 10⁶

Adjustment Factors

Materials F_M
Temp. F_T
Pressure F_p
Size F_{Mag}

Purchased Equipment Cost E [($E = B \times (F_M \times F_T \times F_p \times F_{Mag})$)] \$E .8057 x 10⁶

Field Materials

Piping % x B
Concrete "
Steel "
Instruments "
Electrical "
Insulation "
Paint "

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Subtotal Field Materials (M) % x B	.817 of B	\$M	$.4467 \times 10^6$
Total Direct Material (E+M)		\$(E+M)	1.2524×10^6
Labor Component (L) % x B	.626 of B	\$L	$.3421 \times 10^6$
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	1.5945×10^6
Indirect Construction Costs	.36 of (E+M+L)		$\frac{.574 \times 10^6}{2.1685 \times 10^6}$

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$2.472 \times 10^6$

THE BDM CORPORATION

KOPPERS-TOTZEK/SNG

SUBSYSTEM COST DATA

20A - CO SHIFT SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 3-V-1 to 5

Category: Shift and Hydrolysis Vessels Subsystems

Number of Units (4 vertical and horizontal vessels are included in prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B: \$43,200

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_P
Size	F_{Mag}

Purchased Equipment Cost E $[(E = B \times (F_M \times F_T \times F_P \times F_{Mag}))]$ \$E 110,400

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	1.48 of B	\$M	\$64,100
Total Direct Material (E+M)		$\$(E+M)$	<u>174,500</u>
Labor Component (L) % x B	.931 of B	\$L	<u>40,200</u>
Subtotal Installed Equipment (E+M+L)		$\$(E+M+L)$	214,700
Indirect Construction Costs	.36 of (E+M+L)		<u>77,300</u>
			<u>\$292,000</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$0.3329 \times 10^6$

THE BDM CORPORATION

KOPPERS-TOTZEK/SNG

SUBSYSTEM COST DATA

20A - CO SHIFT SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 90-P-1 and 90-P-2.

Category: Centrifugal Pumps & Motor Subsystems

Number of Units: (4 pumps and motors are included in prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : $\$.0282 \times 10^6$

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E [$E = B \times (F_M \times F_T \times F_p \times F_{Mag})$] $\$E \quad \$.048 \times 10^6$

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.745 of B	\$M	\$21,000
Total Direct Material (E+M)		<u>\$(E+M)</u>	<u>69,000</u>
Labor Component (L) % x B	.71 of B	\$L	<u>20,000</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	89,000
Indirect Construction Costs	.36 of (E+M+L)		<u>32,000</u>
			<u>\$121,000</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$.138 \times 10^6$

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 20A, ALTERNATE PRODUCTS/SHIFT CONVERSION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE 1</u>
TOTAL DIRECT PLUS INDIRECT COSTS	\$2.472
SUBSYSTEM: HEAT EXCHANGERS	.333
SUBSYSTEM: VERTICAL VESSELS	.138
SUBSYSTEM: CENTRIFUGAL PUMPS	2.943
<u>SUBTOTAL:</u>	-0-
TOTAL PROCESS CONTINGENCY: 0%	
<u>SUBTOTAL:</u>	\$2.943
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	

THE BDM CORPORATION

SYSTEM COST DATA

PROCESS: KOPPERS - TOTZEK/SNG

SYSTEM: 20B - ALTERNATE PRODUCTS/MAIN METHANATION

UNIT OPERATION NUMBER: 91 - METHANATION

SUBSYSTEMS: HEAT EXCHANGERS
VESSELS
PUMPS & MOTORS
TURBINE AND COMPRESSOR

REFERENCE SOURCE FOR COSTING: GUTHRIE, PROCESS PLANT ESTIMATING,
EVALUATION AND CONTROL

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS:

- (1) SEE FOLLOWING PAGES FOR A LISTING OF ALL THE EQUIPMENT COSTS (MID-1978 DOLLARS).
- (2) THE K-T/SNG ALTERNATE PRODUCTS METHANATION SYSTEM WAS DESIGNED AT THE EQUIPMENT LEVEL AND EACH MAJOR EQUIPMENT ITEM PRICED BASED UPON GUTHRIE.

COMPUTATION METHOD: N/A

INPUTS: N/A

RESULTS:
TOTAL SYSTEM COST = $\$13.670 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

KOPPERS-TOTZEK/SNG

SYSTEM COST DATA

20B - MAIN METHANATION

<u>Item</u>	<u>Type</u>	(B) (Mid-1978) Base Equipment Cost-Each	(E) (Mid-1978) Equipment Cost-Each	<u>Number Required</u>
92-E-1	Shell & Tube Heat Exgr.	\$ 68,600	\$107,800	1
92-E-2	Shell & Tube Heat Exgr.	110,000	371,000	1
92-E-3	Shell & Tube Heat Exgr.	110,000	190,100	2
92-E-4	Shell & Tube Heat Exgr.	49,000	73,200	1
92-E-5	Shell & Tube Heat Exgr.	176,500	155,800	2
93-E-6	Shell & Turbe Heat Exgr.	82,300	101,600	2
92-E-7	Shell & Tube Heat Exgr.	31,400	46,600	1
92-E-8	Shell & Tube Heat Exgr.	19,600	22,600	1
92-E-9	Shell & Tube Heat Exgr.	23,500	27,300	1
92-E-10	Shell & Tube Heat Exgr.	29,400	34,400	1
92-EA-1	Air-Cooled Heat Exgr.	21,600	24,200	1
92-EA-2	Air-Cooled Heat Exgr.	9,800	11,000	1
92-RX-1	Vertical Vessel	36,500	176,300	2
92-RX-2	Methanation Reactor	33,000	167,000	1
92-RX-3	Methanation Reactor	10,000	50,600	1
92-V-1	Horizontal Vessel	36,500	80,300	1
92-V-2	Horizontal Vessel	4,200	9,200	1
92-V-3	Horizontal Vessel	1,500	5,300	1
92-V-4	Horizontal Vessel	5,500	24,400	1

THE BDM CORPORATION

3-P-1	Centrifugal Pump & Motor	\$ 3,100	\$ 5,000	2
3-P-2	Centrifugal Pump & Motor	1,200	2,000	2
90-EX-1	Turbine Expander & Motor	1,082,000	1,213,000	1
90-C-1	Recycle Compressor & Motor	1,541,000	1,687,000	1

THE BDM CORPORATION

KOPPERS-TOTZEK/SNG

SUBSYSTEM COST DATA

208 - MAIN METHANATION SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 92-E-1 to 92-E-10 AND 92-EA-1 to 92-EA-2.

Category: Heat Exchangers Subsystems

Number of Units: (15 were included on the base and equipment prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$ 1.1005×10^6

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E $[(E = B \times (F_M \times F_T \times F_p \times F_{Mag}))]$ \$E 1.6130×10^6

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

THE BDM CORPORATION

Subtotal Field Materials (M) % x B	.834 of B	\$M	$.918 \times 10^6$
Total Direct Material (E+M)		$\$(E+M)$	2.531×10^6
Labor Component (L) % x B	.635 of B	\$L	$.6983 \times 10^6$
Subtotal Installed Equipment (E+M+L)		$\$(E+M+L)$	3.2293×10^6
Indirect Construction Costs	.36 of (E+M+L)		$\frac{1.1625 \times 10^6}{\4.3918×10^6}

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$5.0067 \times 10^6$

THE BDM CORPORATION

KOPPERS-TOTZEK/SNG

SUBSYSTEM COST DATA

20B - MAIN METHANATION SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 92-RX-1 to 92-RX-3 AND 92-V-1 to 92-V-4.

Category: Horizontal and Vertical Subsystems

Number of Units: (8 Horizontal and Vertical vessels are included in prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$163,700

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E $[(E = B \times (F_M \times F_T \times F_p \times F_{Mag}))]$ \$E \$689,400

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

THE BDM CORPORATION

Subtotal Field Materials (M) % x B	2.546 of B	\$M	\$416,700
Total Direct Material (E+M)		\$(E+M)	<u>1,106,100</u>
Labor Component (L) % x B	.934 of B	\$L	<u>152,900</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	1,259,000
Indirect Construction Costs	.36 of (E+M+L)		<u>453,200</u>
			\$1,712,200

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$1.9519 \times 10^6$

THE BDM CORPORATION

KOPPERS-TOTZEK/SNG

SUBSYSTEM COST DATA

20B - MAIN METHANATION SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 92-P-1 to 92-P-2.

Category: Centrifugal Pumps & Motor Subsystems

Number of Units: (4 pumps and motors are included in prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$8,600

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E [$E = B \times (F_M \times F_T \times F_p \times F_{Mag})$] \$E \$14,000

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

THE BDM CORPORATION

Subtotal Field Materials (M) % x B	.744 of B	\$M	\$6,400
Total Direct Material (E+M)		\$(E+M)	<u>20,400</u>
Labor Component (L) % x B	.721 of B	\$L	<u>6,200</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	26,600
Indirect Construction Costs	.36 of (E+M+L)		<u>9,600</u>
			<u>\$36,200</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT \$ 0412 x 10⁶

THE JM CORPORATION

KOPPERS-TOTZEK/SNG

SUBSYSTEM COST DATA

20B - MAIN METHANATION SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 90-EX-1 AND 90-C-1.

Category: Turbine Expander and Compressor Subsystem

Number of Units: 2

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B: \$2,623,000

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E $[(E = B \times (F_M \times F_T \times F_p \times F_{Mag}))]$ \$E 2,900,000

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.242 of B	\$M	\$635,000
Total Direct Material (E+M)		\$(E+M)	<u>3,535,000</u>
Labor Component (L) % x B	.632 of B	\$L	<u>765,000</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	4,300,000
Indirect Construction Costs	.36 of (E+M+L)		<u>1,550,000</u>
			<u>\$5,850,000</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$6.670 \times 10^6$

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 20B ALTERNATE PRODUCTS/MAIN METHANATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>SNG MODULE</u> 1
TOTAL DIRECT PLUS INDIRECT COSTS	
SUBSYSTEM: HEAT EXCHANGERS	\$ 5.007
SUBSYSTEM: VESSELS	1.952
SUBSYSTEM: CENTRIFUGAL PUMPS	.041
SUBSYSTEM: EXPANDER AND COMPRESSOR	6.670
TOTAL PROCESS CONTINGENCY: 0%	
<u>SUBTOTAL:</u>	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$ 13.670

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SYSTEM COST DATA

PROCESS: KOPPERS-TOTZEK/SNG

SYSTEM: 20C - ALTERNATE PRODUCTS/GAS DRYING

UNIT OPERATION NUMBER: 92 - GAS DRYING

REFERENCE SOURCE FOR COSTING: C.F. BRAUN
FE-2240-31

REFERENCE SYSTEM COST: $\$.400 \times 10^6$ (1977 DOLLARS)

REFERENCE CAPACITY: 15271 LB-MOL/HR GAS FEED

TVA CAPACITY: 6266 LB-MOL/HR GAS FEED

RECOMMENDED CAPACITY EXPONENT: 0.6

EXPLANATORY COMMENTS: N/A

COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST \times INDIRECT CONSTRUCTION COSTS \times CAPACITY FACTOR \times ESCALATION FACTOR

$$\text{CAPACITY FACTOR} = \left(\frac{\text{TVA CAP}}{\text{REF CAP}} \right)^{0.6}$$

INPUTS:

REFERENCE COSTS = $\$.400 \times 10^6$ (1977 DOLLARS)

INDIRECT CONSTRUCTION COSTS = 1.10 (I.E., ENGINEERING AND HOME OFFICE)

$$\text{CAPACITY FACTOR} = \left(\frac{6,266}{15,271} \right)^{0.6} = 0.586$$

ESCALATION FACTOR = 1.22 (TO JANUARY 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$.3146 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
 KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 20C, ALTERNATE PRODUCTS/GAS DRYING
 SUBSYSTEM INVESTMENT AGGREGATION TABLE

SYSTEM CAPITAL INVESTMENT TABLE

SNG
 MODULE
 1

ITEM DESCRIPTION

TOTAL DIRECT PLUS INDIRECT COSTS

\$.315

SUBTOTAL:

TOTAL PROCESS CONTINGENCY: 0%

-0-

SUBTOTAL:

\$.315

TOTAL SYSTEM CAPITAL INVESTMENT:

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS

KOPPERS-TOTZEK/SNG PROCESS, SYSTEM NO. 20, ALTERNATE PRODUCTS SYSTEMS SYSTEM INVESTMENT AGGREGATION TABLE

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	<u>K-T/SNG MODULE 1</u>
TOTAL DIRECT PLUS INDIRECT COSTS	
SYSTEM: SHIFT CONVERSION	\$ 2.943
SYSTEM: MAIN METHANATION	13.670
SYSTEM: GAS DRYING	.315
<u>SUBTOTAL:</u>	\$ 16.928
TOTAL PROCESS CONTINGENCY: 0%	
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$16.928

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SYSTEM COST DATA

PROCESS: TEXACO/SNG

SYSTEM: 20A - ALTERNATE PRODUCTS/CO SHIFT

UNIT OPERATION NUMBER: 90 - SHIFT CONVERSION

SUBSYSTEMS: HEAT EXCHANGERS
VESSELS
PUMPS & MOTORS

REFERENCE SOURCE FOR COSTING: GUTHRIE, PROCESS PLANT ESTIMATING,
EVALUATION AND CONTROL

REFERENCE SYSTEM COST: N/A

REFERENCE CAPACITY: N/A

TVA CAPACITY: N/A

RECOMMENDED CAPACITY EXPONENT: N/A

EXPLANATORY COMMENTS: (1) SEE FOLLOWING PAGES FOR A
LISTING OF ALL THE EQUIPMENT
COSTS (MID-1978 DOLLARS).

(2) THE TEXACO/SNG ALTERNATE PRODUCTS CO
SHIFT SYSTEM WAS DESIGNED AT THE
EQUIPMENT LEVEL AND EACH MAJOR
EQUIPMENT ITEM PRICED BASED UPON
GUTHRIE.

COMPUTATION METHOD: N/A

INPUTS: N/A

RESULTS:

TOTAL SYSTEM COST = $\$4.204 \times 10^6$ (JANUARY 1980 DOLLARS)

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TEXACO/SNG

SYSTEM COST DATA

20A - CO SHIFT SYSTEM

<u>Item</u>	<u>Type</u>	(B) (Mid-1978) Base Equipment Cost-Each	(E) (Mid-1978) Equipment Cost-Each	<u>Number Required</u>
90-E-1	Shell & Tube Heat Exgr.	\$ 58,800	\$ 95,200	2
90-E-2	Shell & Tube Heat Exgr.	57,500	90,300	1
90-E-3	Shell & Tube Heat Exgr.	31,400	49,600	1
90-E-4	Shell & Tube Heat Exgr.	75,500	117,100	4
90-E-5	Shell & Tube Heat Exgr.	82,700	91,600	3
90-E-6	Shell & Tube Heat Exgr.	36,300	33,400	1
90-E-7	Shell & Tube Heat Exgr.	19,600	21,500	1
90-EA-1	Air-Cooled Heat Exgr.	\$ 21,600	\$ 25,300	1
90-EA-2	Air-Cooled Heat Exgr.	16,700	19,500	1
90-RX-1	CO Shift Reactor Vessel	22,000	50,600	1
90-RX-2	COS Hydrolysis Reactor Vessel	8,100	18,600	1
90-V-1	Shift Condensate Vessel	11,500	36,000	1
90-V-2	Hydroysis Condensate Vessel	1,600	5,200	1
90-P-1	Centrifugal Pump & Motor	\$ 12,000	\$ 20,700	2
90-P-2	Centrifugal Pump & Motor	2,100	3,300	2

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TEXACO/SNG

SUBSYSTEM COST DATA

20A - CO SHIFT SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 90-E-1 to E-7 and 90-EA-1 to 90-EA-2.

Category: Heat Exchangers Subsystems

Number of Units: (15 subsystems were included on the base and equipment price below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B: \$.8508 x 10⁶

Adjustment Factors

Materials	F _M
Temp.	F _T
Pressure	F _p
Size	F _{Mag}

Purchased Equipment Cost E [(E = B x (F_M x F_T x F_p x F_{Mag}))] \$E 1.1732 x 10⁶

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.823 of B	\$M	$.7002 \times 10^6$
Total Direct Material (E+M)		\$(E+M)	1.8734×10^6
Labor Component (L) % x B	.628 of B	\$L	$.5344 \times 10^6$
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	2.4078×10^6
Indirect Construction Costs	.36 of (E+M+L)		$.8668 \times 10^6$
			$\$ 3.275 \times 10^6$

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$3.733 \times 10^6$

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TEXACO/SNG

SUBSYSTEM COST DATA

20A - CO SHIFT SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 90-RX-1 to 90-RX-2 and 90-V-1 to 90-V-2.

Category: Shift and Hydrolysis Vessels Subsystems

Number of Units (4 vertical and horizontal vessels are included in prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B: \$43,200

Adjustment Factors

Materials F_M
Temp. F_T
Pressure F_p
Size F_{Mag}

Purchased Equipment Cost E $[(E = B \times (F_M \times F_T \times F_p \times F_{Mag}))]$ \$E 110,400

Field Materials

Piping % x B
Concrete "
Steel "
Instruments "
Electrical "
Insulation "
Paint "

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Subtotal Field Materials (M) % x B	1.48 of B	\$M	\$64,100
Total Direct Material (E+M)		<u>\$(E+M)</u>	<u>174,500</u>
Labor Component (L) % x B	.931 of B	\$L	<u>40,200</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	214,700
Indirect Construction Costs	.36 of (E+M+L)		<u>77,300</u>
			<u>\$292,000</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$0.3329 \times 10^6$

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TEXACO/SNG

SUBSYSTEM COST DATA

20A - CO SHIFT SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 90-P-1 AND 90-P-2.

Category: Centrifugal Pumps & Motor Subsystems

Number of Units: (4 pumps and motors are included in prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : $\$.0282 \times 10^6$

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E $[(E = B \times (F_M \times F_T \times F_p \times F_{Mag}))]$ $\$E \quad \$.048 \times 10^6$

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.745 of B	\$M	\$21,000
Total Direct Material (E+M)		$\$(E+M)$	<u>69,000</u>
Labor Component (L) % x B	.71 of B	\$L	<u>20,000</u>
Subtotal Installed Equipment (E+M+L)		$\$(E+M+L)$	89,000
Indirect Construction Costs	.36 of (E+M+L)		<u>32,000</u>
			<u>\$121,000</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$.138 \times 10^6$

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
 TEXACO/SNG PROCESS, SYSTEM NO. 20A, ALTERNATE PRODUCTS/CO-SHIFT

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	SNG MODULE 2
TOTAL DIRECT PLUS INDIRECT COSTS	
SUBSYSTEM: HEAT EXCHANGERS	\$3.733
SUBSYSTEM: VERTICAL VESSELS	.333
SUBSYSTEM: CENTRIFUGAL PUMPS	.138
<u>SUBTOTAL:</u>	\$ 4.204
TOTAL PROCESS CONTINGENCY: 0%	
<u>SUBTOTAL:</u>	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$4.204

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TEXACO/SNG SYSTEM COST DATA

<u>PROCESS:</u>	TEXACO/SNG
<u>SYSTEM:</u>	20B - ALTERNATE PRODUCTS/MAIN METHANATION
<u>UNIT OPERATION NUMBER:</u>	91 - METHANATION
<u>SUBSYSTEMS:</u>	HEAT EXCHANGERS VESSELS PUMPS & MOTORS TURBINE AND COMPRESSOR
<u>REFERENCE SOURCE FOR COSTING:</u>	GUTHRIE, <u>PROCESS PLANT ESTIMATING,</u> <u>EVALUATION AND CONTROL</u>
<u>REFERENCE SYSTEM COST:</u>	N/A
<u>REFERENCE CAPACITY:</u>	N/A
<u>TVA CAPACITY:</u>	N/A
<u>RECOMMENDED CAPACITY EXPONENT:</u>	N/A
<u>EXPLANATORY COMMENTS:</u>	(1) SEE FOLLOWING PAGES FOR A LISTING OF ALL THE EQUIPMENT COSTS (MID-1978 DOLLARS). (2) THE K-T/SNG ALTERNATE PRODUCTS METHANATION SYSTEM WAS DESIGNED AT THE EQUIPMENT LEVEL AND EACH MAJOR EQUIPMENT ITEM PRICED BASED UPON GUTHRIE.
<u>COMPUTATION METHOD:</u>	N/A
<u>INPUTS:</u>	N/A
<u>RESULTS:</u>	

TOTAL SYSTEM COST = $\$13.670 \times 10^6$ (JANUARY 1980 DOLLARS)

THE BDM CORPORATION

TEXACO/SNG

SYSTEM COST DATA

20B - MAIN METHANATION

<u>Item</u>	<u>Type</u>	(B) (Mid-1978) Base <u>Equipment Cost-Each</u>	(E) (Mid-1978) <u>Equipment Cost-Each</u>	<u>Number Required</u>
92-E-1	Shell & Tube Heat Exgr.	\$ 68,600	\$107,800	1
92-E-2	Shell & Tube Heat Exgr.	110,000	371,000	1
92-E-3	Shell & Tube Heat Exgr.	110,000	190,100	2
92-E-4	Shell & Tube Heat Exgr.	49,000	73,200	1
92-E-5	Shell & Tube Heat Exgr.	176,500	155,800	2
93-E-6	Shell & Tube Heat Exgr.	82,300	101,600	2
92-E-7	Shell & Tube Heat Exgr.	31,400	46,600	1
92-E-8	Shell & Tube Heat Exgr.	19,600	22,600	1
92-E-9	Shell & Tube Heat Exgr.	23,500	27,300	1
92-E-10	Shell & Tube Heat Exgr.	29,400	34,400	1
92-EA-1	Air-Cooled Heat Exgr.	21,600	24,200	1
92-EA-2	Air-Cooled Heat Exgr.	9,800	11,000	1
92-RX-1	Vertical Vessel	36,500	176,300	2
92-RX-2	Methanation Reactor	33,000	167,000	1
92-RX-3	Methanation Reactor	10,000	50,600	1
92-V-1	Horizontal Vessel	36,500	80,300	1
92-V-2	Horizontal Vessel	4,200	9,200	1
92-V-3	Horizontal Vessel	1,500	5,300	1
92-V-4	Horizontal Vessel	5,500	24,400	1

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3-P-1	Centrifugal Pump & Motor	\$ 3,100	\$ 5,000	2
3-P-2	Centrifugal Pump & Motor	1,200	2,000	2
90-EX-1	Turbine Expander	1,082,000	1,213,000	1
90-C-1	Recycle Compressor	1,541,000	1,687,000	1

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TEXACO/SNG

SUBSYSTEM COST DATA

20B - MAIN METHANATION SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 92-E-1 to 92-E-9 and 92-EA-1 to 92-EA-2.

Category: Heat Exchangers Subsystems

Number of Units: (15 subsystems were included on the base and equipment prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$ 1.1005×10^6

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E $[(E = B \times (F_M \times F_T \times F_p \times F_{Mag}))]$ \$E 1.6130×10^6

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.834 of B	\$M	$.918 \times 10^6$
Total Direct Material (E+M)		\$(E+M)	2.531×10^6
Labor Component (L) % x B	.635 of B	\$L	$.6983 \times 10^6$
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	3.2293×10^6
Indirect Construction Costs	.36 of (E+M+L)		$\frac{1.1625 \times 10^6}{\4.3918×10^6}

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$5.0067 \times 10^6$

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TEXACO/SNG

SUBSYSTEM COST DATA

20B - MAIN METHANATION SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 92-RX-1 to 92-RX-3 and 92-V-1 to 92-V-4.

Category: Horizontal and Vertical Subsystems

Number of Units: (8 Horizontal and Vertical vessels are included in prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$163,700

Adjustment Factors

Materials F_M
Temp. F_T
Pressure F_P
Size F_{Mag}

Purchased Equipment Cost E [$E = B \times (F_M \times F_T \times F_P \times F_{Mag})$] \$E \$689,400

Field Materials

Piping % x B
Concrete "
Steel "
Instruments "
Electrical "
Insulation "
Paint "

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Subtotal Field Materials (M) % x B	2.546 of B	\$M	\$416,700
Total Direct Material (E+M)		\$(E+M)	<u>1,106,100</u>
Labor Component (L) % x B	.934 of B	\$L	<u>153,900</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	1,259,000
Indirect Construction Costs	.36 of (E+M+L)		<u>453,200</u>
			\$1,712,200

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$1.9519 \times 10^6$

THE BDM CORPORATION

TEXACO/SNG

SUBSYSTEM COST DATA

20B - MAIN METHANATION SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 92-P-1 to 92-P-2.

Category: Centrifugal Pumps & Motor Subsystems

Number of Units: (4 pumps and motors are included in prices below)

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B: \$8,600

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E [(E = Bx($F_M \times F_T \times F_p \times F_{Mag}$))] \$E \$14,000

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.744 of B	\$M	\$6,400
Total Direct Material (E+M)		\$(E+M)	<u>20,400</u>
Labor Component (L) % x B	.721 of B	\$L	<u>6,200</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	26,600
Indirect Construction Costs	.36 of (E+M+L)		<u>9,600</u>
			<u>\$36,200</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT

$\$.0412 \times 10^6$

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TEXACO/SNG

SUBSYSTEM COST DATA

20B - MAIN METHANATION SYSTEM

ESTIMATE OF MODULAR EQUIPMENT COST

Equipment Number: 90-EX-1 and 90-C-1.

Category: Turbine Expander and Compressor Subsystem

Number of Units: 2

Design Data:

Size
Duty
Etc. (Temp./Press.)
Special Materials
Special Conditions

Cost Estimate:

Base Equipment Cost B : \$2,623,000

Adjustment Factors

Materials	F_M
Temp.	F_T
Pressure	F_p
Size	F_{Mag}

Purchased Equipment Cost E [$E = B \times (F_M \times F_T \times F_p \times F_{Mag})$] \$E 2,900,000

Field Materials

Piping	% x B
Concrete	"
Steel	"
Instruments	"
Electrical	"
Insulation	"
Paint	"

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Subtotal Field Materials (M) % x B	.242 of B	\$M	\$635,000
Total Direct Material (E+M)		\$(E+M)	<u>3,535,000</u>
Labor Component (L) % x B	.632 of B	\$L	<u>765,000</u>
Subtotal Installed Equipment (E+M+L)		\$(E+M+L)	4,300,000
Indirect Construction Costs	.36 of (E+M+L)		<u>1,550,000</u>
			<u>\$5,850,000</u>

(Indirect Construction Costs may be applied either as % of (E+M+L) or as multiplier factor [(E+M+L)] to derive module cost.)

Escalation to January 1980 dollars 1.14

TOTAL MODULE COST, EQUIPMENT $\$6.670 \times 10^6$

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 20B, ALTERNATE PRODUCTS/MAIN METHANATION

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	SNG MODULE 2
TOTAL DIRECT PLUS INDIRECT COSTS	
SUBSYSTEM: HEAT EXCHANGERS	\$5.007
SUBSYSTEM: VESSELS	1.952
SUBSYSTEM: CENTRIFUGAL PUMPS AND MOTORS	.041
SUBSYSTEM: TURBINE EXPANDER AND COMPRESSOR	6.670
<u>SUBTOTAL:</u>	\$ 13.670
TOTAL PROCESS CONTINGENCY: 0%	
<u>SUBTOTAL:</u>	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$13.670

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SYSTEM COST DATA

PROCESS: TEXACO/SNG
SYSTEM: 20C - ALTERNATE PRODUCTS/GAS DRYING
UNIT OPERATION NUMBER: 92 - GAS DRYING
REFERENCE SOURCE FOR COSTING: C.F. BRAUN
FE-2240-31
REFERENCE SYSTEM COST: $\$.400 \times 10^6$ (1977 DOLLARS)
REFERENCE CAPACITY: 15271 LB-MOL/HR GAS FEED
TVA CAPACITY: 7,148 LB-MOL/HR GAS FEED
RECOMMENDED CAPACITY EXPONENT: 0.6
EXPLANATORY COMMENTS: N/A
COMPUTATION METHOD:

TOTAL SYSTEM COST = REFERENCE SYSTEM COST \times INDIRECT CONSTRUCTION COSTS \times CAPACITY FACTOR \times ESCALATION FACTOR

$$\text{CAPACITY FACTOR} = \left(\frac{\text{TVA CAP}}{\text{REF CAP}} \right)^{0.6}$$

INPUTS:

REFERENCE COSTS = $\$.400 \times 10^6$ (1977 DOLLARS)

INDIRECT CONSTRUCTION COSTS = 1.10 (I.E. ENGINEERING AND HOME OFFICE)

$$\text{CAPACITY FACTOR} = \left(\frac{7,148}{15,271} \right)^{0.6} = 0.634$$

ESCALATION FACTOR = 1.22 (TO JANUARY 1980 DOLLARS)

RESULTS:

TOTAL SYSTEM COST = $\$.3403 \times 10^6$ (JANUARY 1980 DOLLARS)

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CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS
 TEXACO/SNG PROCESS, SYSTEM NO. 20C, ALTERNATE PRODUCTS/GAS DRYING
 SUBSYSTEM INVESTMENT AGGREGATION TABLE

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	SNG MODULE 2
TOTAL DIRECT PLUS INDIRECT COSTS	. 340
<u>SUBTOTAL:</u>	
TOTAL PROCESS CONTINGENCY: 0%	-0-
<u>SUBTOTAL:</u>	
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$.340

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS TEXACO/SNG PROCESS, SYSTEM NO. 20, ALTERNATE PRODUCTS SYSTEMS SYSTEM INVESTMENT AGGREGATION TABLE

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	TEXACO/SNG MODULE 2
TOTAL DIRECT PLUS INDIRECT COSTS	
SYSTEM: SHIFT CONVERSION	\$ 4.204
SYSTEM: MAIN METHANATION	13.670
SYSTEM: GAS DRYING	.340
<u>SUBTOTAL:</u>	\$18.214
TOTAL PROCESS CONTINGENCY: 0%	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$18.214

THE BDM CORPORATION

CAPITAL INVESTMENT, MILLIONS OF 1980 DOLLARS KOPPERS-TOTZEK/TEXACO/SNG PROCESS, SYSTEM NO. 20, ALTERNATE PRODUCTS SYSTEMS SYSTEM INVESTMENT AGGREGATION TABLE

SYSTEM CAPITAL INVESTMENT TABLE

<u>ITEM DESCRIPTION</u>	K-T/SNG MODULE 1	TEXACO/SNG MODULE 2
TOTAL DIRECT PLUS INDIRECT COSTS		
SYSTEM: SHIFT CONVERSION	\$ 2.943	\$ 4.204
SYSTEM: MAIN METHANATION	13.670	13.670
SYSTEM: GAS DRYING	.315	.340
<u>SUBTOTAL:</u>	\$16.928	\$18.214
TOTAL PROCESS CONTINGENCY: 0%	-	-0-
<u>TOTAL SYSTEM CAPITAL INVESTMENT:</u>	\$16.928	\$18.214

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e. **Koppers-Totzek/Texaco/SNG "Instant Plant" Capital Costs**

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FACILITY INVESTMENT AGGREGATION TABLE
KOPPERS-TOTZEK/TEXACO/SNG
MILLIONS OF 1980 DOLLARS

ITEM DESCRIPTION	SYSTEM NO.	K-T/SNG MODULE 1	TEXACO/SNG MODULE 2	TEXACO/MBG MODULE 3	TEXACO/MBG MODULE 4	GENERAL FACILITIES	TOTAL
SYSTEM CAPITAL INVESTMENT							
COAL PREPARATION & FEED	1		INCLUDED IN SYSTEM 2				
GASIFICATION	2	86.604	24.180	24.180	24.180		159.144
INITIAL GAS CLEANUP & COOLING	3	-0-	13.813	13.813	13.813		41.439
ACID GAS REMOVAL	4	38.693	42.826	42.826	42.826		167.171
SULFUR RECOVERY & TAILGAS TREATMENT	5	26.373	13.186	13.186	13.186		65.931
AIR SEPARATION	6	74.700	108.000	72.000	108.000		362.700
GAS COMPRESSION	7	22.638	-0-	-0-	-0-		22.638
PROCESS SOLIDS TREATMENT	8	.860	.725	.725	.725		3.035
INCINERATION	9	-0-	-0-	-0-	-0-		-0-
INSTRUMENTATION & CONTROL	10	4.669	4.669	4.669	4.669		18.676
COAL HANDLING	11	-0-	-0-	-0-	-0-	64.214	64.214
SOLIDS WASTE RECYCLING/DISPOSAL	12	21.494	21.494	21.494	21.494		85.976
BYPRODUCTS PROCESSING	13	1.000	1.000	1.000	1.000		4.000
PLANT POWER SYSTEM	14	35.347	55.571	55.571	55.571		202.060
STEAM GENERATION/DISTRIBUTION	15	6.833	8.381	5.340	5.340		25.894
WATER SUPPLY	16	5.458	2.279	2.279	2.279		12.295
COOLING WATER SYSTEM	17	6.028	6.871	6.871	6.871		26.641
WASTE WATER TREATMENT	18	.208	.038	.038	.038		.322
GENERAL FACILITIES (LESS BLDG & SUPPORT)	19	-0-	-0-	-0-	-0-	46.740	46.740
ALTERNATE PRODUCTS SYSTEMS	20	16.928	18.214	-0-	-0-		35.142
SUBTOTAL (LESS BLDG & SUPPORT)							
(1) TOTAL SYSTEM CAPITAL INVESTMENT*		347.833	321.247	263.992	299.992	110.954	1297.278
(2) PROJECT CONTINGENCY 15 %		52.175	48.187	39.599	44.999	16.643	1344.018
[15% OF (1)]							201.603
(3) CONTRACTOR'S FEE 4 %		16.000	14.777	12.144	13.800	5.104	61.825
[4% OF (1) + (2)]							32.149
(4) OWNER'S COSTS 2 %		8.320	7.684	6.315	7.176	2.654	32.149
[2% OF (1)+(2)+(3)]							
TOTAL FACILITY INVESTMENT		424.328	391.895	322.050	365.967	135.355	1639.595
[(1)+(2)+(3)+(4)]							

* INCLUDES PROCESS CONTINGENCIES WHICH TOTAL:

THE BDM CORPORATION

OTHER CAPITALIZED COSTS AND WORKING CAPITAL KOPPERS-TOTZEK/TEXACO/SNG MILLIONS OF 1980 DOLLARS

ITEM DESCRIPTION	1	2	3	4	FACILITIES	TOTAL
A. OTHER CAPITALIZED COSTS						
PAID-UP ROYALTIES 0.5 %	2.122	1.959	1.610	1.830	.677	8.198
START-UP AND TESTING	91.098	72.868	73.378	73.378		310.722
ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION	93.728	85.664	72.723	80.212	28.193	360.520
SUBTOTAL OF OTHER CAPITALIZED COSTS	<u>186.948</u>	<u>160.491</u>	<u>147.711</u>	<u>155.420</u>	<u>28.870</u>	<u>679.440</u>
B. WORKING CAPITAL						
INITIAL CHARGE OF CATALYSTS AND CHEMICALS	6.894	5.704	.607	.607		13.812
MATERIALS INVENTORIES	4.269	4.247	4.138	4.138		16.792
SPARE PARTS INVENTORIES	1.923	1.776	1.459	1.659	.613	7.430
MINIMUM CASH BALANCE	13.614	10.889	10.966	10.966		46.435
SUBTOTAL WORKING CAPITAL	<u>26.700</u>	<u>22.616</u>	<u>17.170</u>	<u>17.370</u>	<u>.613</u>	<u>84.469</u>

THE BDM CORPORATION

KOPPERS-TUZEK/TEXACO/SNG PROCESS

LAND REQUIREMENTS

SYSTEM #	DIMENSIONS			AREA PER UNIT FT ²	ACRES	\$/ACRE OR \$/FT ²	UNITS PER SYSTEM	TOTAL AREA PER SYSTEM, ACRES	TOTAL COST
	LAND UNIT	L	W						
SUBTOTAL LAND REQUIREMENT						\$3000	300	\$ 900,000	
LAND SURVEY AND FEES*									\$ 4,000
FIRE CONTROL*									\$ 260,000
ALLOWANCE FOR INTERCONNECTIONS, SITE PREPARATION, MISCELLANEOUS*						\$8100	300	\$2,430,000	
SUBTOTAL DEPRECIABLE LAND RELATED EXPENSES									\$2,694,000
TOTAL									\$3,594,000

* COSTS OBTAINED FROM MITTELHAUSER GUIDE TO ESTIMATE TOTAL CAPITAL REQUIREMENT FOR PROCESSING FACILITIES

THE BDM CORPORATION

TOTAL CAPITAL REQUIREMENTS KOPPERS-TOTZEK/TEXACO/SNG MILLIONS OF 1980 DOLLARS

ITEM DESCRIPTION	K-T/SNG MODULE 1	TEXACO SNG MODULE 2	TEXACO MBG MODULE 3	TEXACO MBG MODULE 4	GENERAL FACILITIES	TOTAL
TOTAL FACILITY INVESTMENT	424.328	391.895	322.050	365.967	135.355	1639.595
OTHER CAPITALIZED COSTS	186.948	160.491	147.711	155.420	28.870	679.440
LAND RELATED COSTS					2.694	2.694
SUBTOTAL DEPRECIABLE INVESTMENT	611.276	552.386	469.761	521.387	166.919	2321.729
WORKING CAPITAL	26.700	22.616	17.170	17.370	0.613	84.469
LAND					0.900	.900
SUBTOTAL NON-DEPRECIABLE INVESTMENT	26.700	22.616	17.170	17.370	1.513	85.369
TOTAL CAPITAL REQUIREMENTS	637.976	575.002	486.931	538.757	168.432	2407.098

THE BDM CORPORATION

f. **Koppers-Totzek/Texaco/SNG Operations and Maintenance Costs**

THE BDM CORPORATION

KOPPERS-TOTZEK/SNG PROCESS MODULE OPERATIONS MANPOWER STAFFING REQUIREMENTS* (INDIVIDUAL MANPOWER REQUIREMENTS FOR MODULE 1)

SYSTEM NO.	OPERATORS PER SHIFT	SHIFTS PER WEEK	UTILITY MEN PER SHIFT	SHIFTS PER WEEK	UNIT SUPVS PER SHIFT	SHIFTS PER WEEK	TOTAL HOURS PER YEAR***
1	1 (\$21,600/yr)	5	1 (\$14.50/hr)	5	1 (\$34,500/yr)	5	6,240.
2	2 (\$14.00/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	8,320.
3	1 (\$13.00/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	6,240.
4	1 (\$21,600/hr)	5	1 (\$14.50/hr)	5	- INCLUDED IN UNIT 1 -		4,160.
5	----- INCLUDED IN UNIT 8 -----						
6	0	0	1 (\$15,200/yr)	7	----INCLUDED IN UNIT 14----		2,912.
7	1 (\$17,900/yr)	21	1 (\$13,100/yr)	7	1 (\$27,600/yr)	21	20,384.
8	1 (\$17,900/yr)	21	1 (\$13,100/yr)	21	1 (\$27,600/yr)	5	19,552.
9	-----INCLUDED IN UNIT 7 -----						
10	2 (\$17,900/yr)	21			---- INCLUDED IN UNIT 7 ----		17,472.
11	0**(\$17,900/yr)	21	1**(\$16,400/yr)	21	--- INCLUDED IN UNIT 12 ---		8,736.
12	2**(\$20,300/yr)	21	2**(\$16,400/yr)	21	1 (\$27,600/yr)	21	43,680.
13	----- INCLUDED IN UNIT 12 -----						
14	1 (\$20,300/yr)	21	1 (\$16,400/yr)	7	1 (\$27,600/yr)	5	13,728.
15	1 (\$17,900/yr)	21	----- INCLUDED IN UNIT 3 -----				8,736.
16	----- INCLUDED IN UNIT 12 -----						
17	1 (\$17,900/yr)	21	0	0	1 (\$27,600/yr)	5	10,816.
18	1 (\$17,900/yr)	21	0	0	----INCLUDED IN UNIT 14 -----		8,736.
19	----- INCLUDED IN UNIT 8, IF REQUIRED -----						
20	5 (\$17,900/yr)	21	3 (\$16,400/yr)	7	2 (\$27,600/yr)	5	56,576
TOTALS							236,288

* TOTAL STAFF = TOTAL STAFF $\frac{\text{HRS}}{\text{YR}} \div \frac{\text{PERSON-HRS}}{\text{YR}} = 179,712 \div 2080 = 113.6$ (USE 113 OR 114 PERSONS)

** DEPENDENT ON GASIFICATION TECHNOLOGY USED. (NUMBER OF GASIFIERS & FEED SYSTEMS PER MODULE AND RELATIVE ATTENTION REQUIRED.)

*** TOTAL HRS PER YEAR = (OPER/SHIFT) x (SHIFTS/WEEK) x (8 WKG HRS/OPER) x (52 WKS/YEAR)
(FOR EACH SYSTEM)

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THE BDM CORPORATION

MODULE OPERATING COST DATA

PROCESS: KOPPERS-TOTZEK/SNG

ITEM: INDIVIDUAL STAFFING REQUIREMENTS COSTS
FOR MODULE I

REFERENCE: TVA DESIGN CRITERIA AND STAFFING NEEDS
DEFINED BY BDM/MITTELHAUSER

METHOD: SYSTEM REQUIRES ONE MORE UTILITY PERSON
THAN B&W DUE TO NUMBER OF GASIFIERS

<u>JOB DESCRIPTION</u>	<u>COMPENSATION RATE</u>	<u>HRS/YEAR</u>	<u>BASE COST/YEAR</u>	<u>FRINGES</u>	<u>TOTAL</u>
<u>I. OPERATING LABOR</u>					
MECHANICAL UNIT					
FOREMAN	\$21,600/year	2,080	\$ 21,600	1.42	\$30,672
ELECTRICIAN	\$14.50/hr	2,080	\$ 30,160	0	30,160
COAL HANDLING					
FOREMAN	\$14.00/hr	4,160	\$ 58,240	0	58,240
LABORER	\$ 8.50/hr	4,160	\$ 35,360	0	35,360
HEAD OPERATOR	\$13.00/hr	2,080	\$ 27,040	0	27,040
INSTRUMENT UNIT					
FOREMAN	\$21,600/yr	2,080	\$ 21,600	1.42	30,672
INSTRUMENT					
MECHANIC	\$14.50/hr	2,080	\$ 30,160	0	30,160
CLASS C OPERATOR	\$15,200/yr	2,912	\$ 21,280*	1.42	30,218
CLASS A OPERATOR	\$17,900/yr	104,832	\$902,160	1.42	1,281,067
PLANT LABORER	\$13,100/yr	11,648	\$ 73,360	1.42	104,171
CLASS B OPERATOR	\$16,400/yr	37,856	\$298,480	1.42	423,842
UNIT OPERATOR	\$20,300/yr	<u>26,208</u>	\$255,780	1.42	<u>363,208</u>
SUBTOTAL OPERATING LABOR		202,176			\$2,444,810
<u>II. SUPERVISION</u>					
PLANT OPERATING					
SUPERVISOR	\$34,500/year	2,080	\$ 34,500	1.42	\$ 48,990
YARD OPERATIONS					
SUPERVISOR	\$24,000/year	4,160	48,000	1.42	68,160
SHIFT ENGINEER	\$27,600/year	<u>27,872</u>	369,840	1.42	<u>525,173</u>
SUBTOTAL SUPERVISION		34,112			\$642,323
TOTAL STAFF REQUIREMENTS		227,552			\$3,087,133

* WHEN COMPENSATION RATE IS GIVEN IN \$/OPER/YR

BASE COST/YEAR = [(HRS/YEAR) ÷ (2080 HRS/OPER)] · (\$/OPER/YR)

THE BDM CORPORATION

KOPPERS-TOTZEK/SNG PROCESS OPERATING REQUIREMENTS FOR EXPECTED OPERATIONS (INDIVIDUAL OPERATING REQUIREMENTS FOR MODULE 1)

	BASIS	UNITS
Raw Materials		
Coal	TPY @ 100% Operation	1,825,000 TPY
Catalyst and Chemical Makeup	@ 100% Operation	\$ 1,838,820 /Yr
Initial Charge of Catalysts & Chemicals		\$ 6,893,800
Utility Requirements		
Water		2,200 gallons/min
Import Power	Kwh/Yr @ 100% Operation	1,092,882,508 Kw-Hr/Yr
Steam		
Operating Requirements		
Labor:		
Supervisors	mh/Yr	34,112
Operators	mh/Yr	202,176
Supplies	Factored as 15% of operating labor costs	
Maintenance Requirements		
Labor	Factored as 1.6% of average modular total system cost	
Supplies	Factored as 2.4% of average modular total system cost	
General Plant Staff	Factored as 30% of operating labor and maintenance labor & supervision	
Administration and Plant Overhead	Factored as 5% of operations & maintenance less feedstock and chemicals	
TOTAL NET SNG YIELD	@ 100% Operation	19,464,720 MMBTU/YEAR

THE BDM CORPORATION

KOPPERS-TOTZEK/SNG PROCESS ANNUAL MODULE OPERATING COSTS FOR EXPECTED OPERATIONS (INDIVIDUAL COSTS FOR MODULE 1) MILLIONS OF JANUARY 1980 DOLLARS

ITEM DESCRIPTION	UNITS	NET REQUIREMENTS (AT 100% OPERATION)	ANNUAL REQUIREMENTS (AT 90% OPERATION)	COST PER UNIT	ANNUAL COST (x 10 ⁶)
FEEDSTOCK: (KENTUCKY #9 SEAM, DEEP MINE)*	MMBTU	1.098 x 10 ⁵ MMBTU/DAY	3.607 x 10 ⁷ MMBTU/YEAR	\$1.25	\$45.087
CATALYST & CHEMICAL MAKE-UP					1.655
SUBTOTAL FEEDSTOCK & CATALYST & CHEMICALS					<u>\$46.742</u>
ELECTRIC POWER - PK/AVG. LOAD FACTOR = 1.5	KWH	124,758 KWH/HR.	983,594,257 KWH/YEAR	\$.027	\$26.557
WATER	10 ³ GALLONS	2200 GALLONS/MIN	1040.4 x 10 ⁶ GALLONS/YR	\$.80/ K GAL	\$ 0.833
OPERATING LABOR	PERSON HRS.	202,176 HRS/YEAR	202,176 HRS/YEAR	\$12.09	\$ 2.444
OPERATING SUPPLIES	(15% OF OPERATING LABOR)				\$.357
MAINTENANCE LABOR	(1.6% OF 1/4 OF TF1)				\$ 6.558
MAINTENANCE SUPPLIES	(2.4% OF 1/4 OF TF1)				\$ 9.838
SUPERVISION	PERSON HRS.		34,112 HRS./YEAR	\$18.82	\$.642
GENERAL PLANT STAFF	(30% OF O.L. AND M.L. AND SUP)				\$ 2.893
ADMINISTRATION AND GENERAL OVERHEAD	(5% OF O&M LESS FEEDSTOCK AND CHEM.)				\$ 2.507
PROPERTY TAXES AND INSURANCE	DESIGN CRITERIA SPECIFY NO COSTS FOR THIS LINE ITEM				-0-
SUBTOTAL O&M COSTS LESS FEED- STOCK & CATALYST & CHEMICALS					<u>\$52.639</u>
GROSS ANNUAL OPERATING & MAINTENANCE COSTS					\$ 99.381
BYPRODUCTS CREDITS					-0-
NET ANNUAL OPERATING & MAINTENANCE COSTS					<u>\$ 99.381</u>

* MEAN BTU VALUE OF FEEDSTOCK = 10,980 BTU/LB.

THE BDM CORPORATION

TEXACO/SNG MODULE MODULE OPERATIONS MANPOWER STAFFING REQUIREMENTS* (INDIVIDUAL MANPOWER REQUIREMENTS FOR MODULE II)

SYSTEM NO.	OPERATORS PER SHIFT	SHIFTS PER WEEK	UTILITY MEN PER SHIFT	SHIFTS PER WEEK	UNIT SUPVS PER SHIFT	SHIFTS PER WEEK	TOTAL HOURS PER YEAR***
1	1 (\$21,600/yr)	5	1 (\$14.50/hr)	5	1 (\$34,500/yr)	5	6,240.
2	2 (\$14.00/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	8,320.
3	1 (\$13.00/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	6,240.
4	1 (\$21,600/yr)	5	1 (\$14.50/hr)	5	- INCLUDED IN UNIT 1 -		4,160.
5	----- INCLUDED IN UNIT 8 -----						
6	0	0	1 (\$15,200/yr)	7	-----INCLUDED IN UNIT 14---		2,912.
7	1 (\$17,900/yr)	21	1 (\$13,100/yr)	7	1 (\$27,600/yr)	21	20,384.
8	1 (\$17,900/yr)	21	1 (\$13,100/yr)	21	1 (\$27,600/yr)	5	19,552.
9	-----INCLUDED IN UNIT 7 -----						
10	2 (\$17,900/yr)	21			----- INCLUDED IN UNIT 7 -----		17,472.
11	0**(\$17,900/yr)	21	1**(\$16,400/yr)	21	--- INCLUDED IN UNIT 12 ---		8,736.
12	2**(\$20,300/yr)	21	2**(\$16,400/yr)	21	1 (\$27,600/yr)	21	34,944.
13	----- INCLUDED IN UNIT 12 -----						
14	1 (\$20,300/yr)	21	1 (\$16,400/yr)	7	1 (\$27,600/yr)	5	13,728.
15	1 (\$17,900/yr)	21			----- INCLUDED IN UNIT 3 -----		8,736.
16	----- INCLUDED IN UNIT 12 -----						
17	1 (\$17,900/yr)	21	0	0	1 (\$27,600/yr)	5	10,816.
18	1 (\$17,900/yr)	21	0	0	-----INCLUDED IN UNIT 14 -----		8,736.
19	----- INCLUDED IN UNIT 8, IF REQUIRED -----						
20	5 (\$17,900/yr)	21	3 (\$16,400/yr)	7	2 (\$27,600/yr)	5	56,576
TOTALS							227,552

* TOTAL STAFF = TOTAL STAFF $\frac{\text{HRS}}{\text{YR}}$ + $\frac{\text{PERSON-HRS}}{\text{YR}}$ = 227,552 + 2080 = 109.4 (USE 109 OR 110 PERSONS)

** DEPENDENT ON GASIFICATION TECHNOLOGY USED. (NUMBER OF GASIFIERS & FEED SYSTEMS PER MODULE AND RELATIVE ATTENTION REQUIRED.)

*** TOTAL HRS PER YEAR = (OPER/SHIFT) x (SHIFTS/WEEK) x (8 WKG HRS/OPER) x (52 WKS/YEAR)
(FOR EACH SYSTEM)

THE BDM CORPORATION

MODULE OPERATING COST DATA

PROCESS: TEXACO/SNG

ITEM: INDIVIDUAL STAFFING REQUIREMENTS COSTS FOR MODULE II

REFERENCE: TVA DESIGN CRITERIA AND STAFFING NEEDS DEFINED BY
BDM/MITTELHAUSER

METHOD:

<u>JOB DESCRIPTION</u>	<u>COMPENSATION RATE</u>	<u>HRS/YEAR</u>	<u>BASE COST/YEAR</u>	<u>FRINGES</u>	<u>TOTAL</u>
<u>I. OPERATING LABOR</u>					
MECHANICAL UNIT					
FOREMAN	\$21,600/YEAR	2,080	\$ 21,600	1.42	\$30,672
ELECTRICIAN	\$14.50/HR	2,080	\$ 30,160	0	30,160
COAL HANDLING					
FOREMAN	\$14.00/HR	4,160	\$ 58,240	0	58,240
LABORER	\$ 8.50/HR	4,160	\$ 35,360	0	35,360
HEAD OPERATOR	\$13.00/HR	2,080	\$ 27,040	0	27,040
INSTRUMENT UNIT					
FOREMAN	\$21,600/YR	2,080	\$ 21,600	1.42	30,672
INSTRUMENT					
MECHANIC	\$14.50/HR	2,080	\$ 30,160	0	30,160
CLASS C OPERATOR	\$15,200/YR	2,912	\$ 21,280*	1.42	30,218
CLASS A OPERATOR	\$17,900/YR	104,832	\$902,160	1.42	1,281,067
PLANT LABORER	\$13,100/YR	11,648	\$ 73,360	1.42	104,171
CLASS B OPERATOR	\$16,400/YR	29,120	\$229,600	1.42	326,032
UNIT OPERATOR	\$20,300/YR	<u>26,208</u>	\$255,780	1.42	<u>363,208</u>
SUBTOTAL OPERATING LABOR		193,440			\$2,347,000
<u>II. SUPERVISION</u>					
PLANT OPERATING					
SUPERVISOR	\$34,500/YR	2,080	\$ 34,500	1.42	\$ 48,990
YARD OPERATIONS					
SUPERVISOR	\$24,000/YR	4,160	\$ 48,000	1.42	68,160
SHIFT ENGINEER	\$27,600/YR	<u>27,872</u>	\$369,840	1.42	<u>525,173</u>
SUBTOTAL SUPERVISION		34,112			\$642,323
TOTAL STAFF REQUIREMENTS		227,552			\$2,989,323

* WHEN COMPENSATION RATE IS GIVEN IN \$/OPER/YEAR

BASE COST/YEAR = [(HRS/YEAR) ÷ (2080 HRS/OPER)] · (\$/OPER/YEAR)

THE BDM CORPORATION

TEXACO/SNG PROCESS OPERATING REQUIREMENTS FOR EXPECTED OPERATIONS (INDIVIDUAL OPERATING REQUIREMENTS FOR MODULE II)

	BASIS	UNITS
Raw Materials		
Coal	TPY @ 100% Operation	1,825,000 TPY
Raw Water (@ 2283 gpm design)	Gallons/Year @ 100% Operation	1.20 Gallon/Year x 10 ⁹
Catalyst and Chemical Makeup		
Makeup	@ 100% Operation	\$ 1,572,720/Year
Initial Charge of Catalysts and Chemicals		\$ 5,703,930
Utility Requirements		
Import Power (@ 37,370 KW)	kwh/Yr @ 100% Operation	327,361,200 kw-Hr/Yr
Operating Requirements		
Labor		
Supervisors	mh/Yr	34,112 mh/Yr
Operators	mh/Yr	193,440 mh/Yr
Supplies	Factored as 1% of operating labor costs	
Maintenance Requirements		
Labor	Factored as 1.6% of average modular total system cost	
Supplies	Factored as 2.4% of average modular total system cost	
General Plant Staff	Factored as 30% of operating labor and maintenance labor & supervision	
Administration and Plant Overhead	Factored as 5% of operations & maintenance less feedstock and chemicals	
Total Net SNG Yield =	@ 100% Operation	22,333,620 MMBTU/YR

THE BDM CORPORATION

TEXACO/SNG PROCESS ANNUAL MODULE OPERATING COSTS FOR EXPECTED OPERATIONS (INDIVIDUAL MODULE COSTS FOR MODULE II) MILLIONS OF JANUARY 1980 DOLLARS

ITEM DESCRIPTION	UNITS	NET REQUIREMENTS (AT 100% OPERATION)	ANNUAL REQUIREMENTS (AT 90% OPERATION)	COST PER UNIT	ANNUAL COST ($\times 10^6$)
FEEDSTOCK: (KENTUCKY #9 SEAM, DEEP MINE)*	MMBTU	1.098×10^5 MMBTU/DAY	3.607×10^7 MMBTU/YEAR	\$1.25	\$45.087
CATALYST & CHEMICAL MAKE-UP					1.415
SUBTOTAL FEEDSTOCK & CATALYST & CHEMICALS					\$46.502
ELECTRIC POWER	KWH	41,936 KW	294,625,080 KWH/YEAR	\$0.027 KWH	\$ 7.955
WATER	10^3 GALLONS	2,283 gpm	1.08×10^9 gal/year	\$.80/ KGAL	\$ 0.864
OPERATING LABOR		193,440 hrs/year	193,440 hrs/year	\$12.13	\$ 2.346
OPERATING SUPPLIES	(15% of Operating Labor)				\$.352
MAINTENANCE LABOR	(1.6% OF 1/4 of Total Facility Investment)				\$ 6.850
MAINTENANCE SUPPLIES	(2.4% OF 1/4 of Total Facility Investment)				\$ 9.838
SUPERVISION		34,112 hrs/year	34,112 hrs/year	\$18.82	\$.642
GENERAL PLANT STAFF	(30% of Operating Labor, Maintenance Labor and Supervision)				\$ 2.864
ADMINISTRATION AND GENERAL OVERHEAD	5% Factor of Subtotal of O&M Expenses (Less Feedstock and Catalysts)				\$ 1.571
PROPERTY TAXES AND INSURANCE					-0-
SUBTOTAL O&M COSTS LESS FEED- STOCK & CATALYST & CHEMICALS					\$ 32.990
GROSS ANNUAL OPERATING & MAINTENANCE COSTS					\$79.492
BYPRODUCTS CREDITS					-0-
NET ANNUAL OPERATING & MAINTENANCE COSTS					\$ <u>79.492</u>

* MEAN BTU VALUE OF FEEDSTOCK = 10,980 BTU/LB.
21.96 MMBTU/TON

THE BDM CORPORATION

TEXACO/MBG PROCESS MODULE OPERATIONS MANPOWER STAFFING REQUIREMENTS* (INDIVIDUAL MANPOWER REQUIREMENTS FOR MODULES III AND IV)

SYSTEM NO.	OPERATORS PER SHIFT	SHIFTS PER WEEK	UTILITY MEN PER SHIFT	SHIFTS PER WEEK	UNIT SUPVS PER SHIFT	SHIFTS PER WEEK	TOTAL HOURS PER YEAR***
1	1 (\$21,600/yr)	5	1 (\$14.50/hr)	5	1 (\$34,500/yr)	5	6,240.
2	2 (\$14.00/hr)		1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	8,320.
3	1 (\$13.00/hr)	5	1 (\$8.50/hr)	5	1 (\$24,000/yr)	5	6,240.
4	1 (\$21,600/yr)	5	1 (\$14.50/hr)	5	- INCLUDED IN UNIT 1 -		4,160.
5	----- INCLUDED IN UNIT 8 -----						
6	0	0	1 (\$15,200/yr)	7	---- INCLUDED IN UNIT 14 ----		2,912.
7	1 (\$17,900/yr)	21	1 (\$13,100/yr)	7	1 (\$27,600/yr)	21	20,384.
8	1 (\$17,900/yr)	21	1 (\$13,100/yr)	21	1 (\$27,600/yr)	5	19,552.
9	----- INCLUDED IN UNIT 7 -----						
10	2 (\$17,900/yr)	21			---- INCLUDED IN UNIT 7 ----		17,472.
11	0** (\$17,900/yr)	21	1** (\$16,400/yr)	21	--- INCLUDED IN UNIT 12 ---		8,736.
12	2** (\$20,300/yr)	21	2** (\$16,400/yr)	21	1 (\$27,600/yr)	21	34,944.
13	----- INCLUDED IN UNIT 12 -----						
14	1 (\$20,300/yr)	21	1 (\$16,400/yr)	7	1 (\$27,600/yr)	5	13,728.
15	1 (\$17,900/yr)	21			----- INCLUDED IN UNIT 3 -----		8,736.
16	----- INCLUDED IN UNIT 12 -----						
17	1 (\$17,900/yr)	21	0	0	1 (\$27,600/yr)	5	10,816.
18	1 (\$17,900/yr)	21	0	0	---- INCLUDED IN UNIT 14 ----		8,736.
19	----- INCLUDED IN UNIT 8, IF REQUIRED -----						
TOTALS							170,976

* TOTAL STAFF = TOTAL STAFF $\frac{\text{HRS}}{\text{YR}} \div \frac{\text{PERSON-HRS}}{\text{YR}} = 170,976 \div 2080 = 82.2$ (USE 82 OR 83 PERSONS)

** DEPENDENT ON GASIFICATION TECHNOLOGY USED. (NUMBER OF GASIFIERS & FEED SYSTEMS PER MODULE AND RELATIVE ATTENTION REQUIRED.)

*** TOTAL HRS PER YEAR = (OPER/SHIFT) x (SHIFTS/WEEK) x (8 WKG HRS/OPER) x (52 WKS/YEAR)
(FOR EACH SYSTEM)

THE BDM CORPORATION

MODULE OPERATING COST DATA

PROCESS: TEXACO/MBG

ITEM: INDIVIDUAL STAFFING REQUIREMENTS COSTS FOR MODULES III AND IV

REFERENCE: TVA DESIGN CRITERIA AND STAFFING NEEDS DEFINED BY
BDM/MITTELHAUSER

METHOD:

<u>JOB DESCRIPTION</u>	<u>COMPENSATION RATE</u>	<u>HRS/YEAR</u>	<u>BASE COST/YEAR</u>	<u>FRINGES</u>	<u>TOTAL</u>
I. OPERATING LABOR					
MECHANICAL UNIT					
FOREMAN	\$21,600/YR	2,080	\$ 21,600	1.42	\$30,672
ELECTRICIAN	\$14.50/HR	2,080	\$ 30,160	0	30,160
COAL HANDLING					
FOREMAN	\$14.00/HR	4,160	\$ 58,240	0	58,240
LABORER	\$ 8.50/HR	4,160	\$ 35,360	0	35,360
HEAD OPERATOR	\$13.00/HR	2,080	\$ 27,040	0	27,040
INSTRUMENT UNIT					
FOREMAN	\$21,600/YR	2,080	\$ 21,600	1.42	30,672
INSTRUMENT MECHANIC	\$14.50/HR	2,080	\$ 30,160	0	30,160
CLASS C OPERATOR	\$15,200/YR	2,912	\$ 21,280	1.42	30,218
CLASS A OPERATOR	\$17,900/YR	61,152	\$526,260	1.42	747,289
PLANT LABORER	\$13,100/YR	11,648	\$ 73,360	1.42	104,171
CLASS B OPERATOR	\$16,400/YR	20,384	\$160,720	1.42	228,222
UNIT OPERATOR	\$20,300/YR	<u>26,208</u>	\$255,780	1.42	<u>363,208</u>
SUBTOTAL OPERATING LABOR		141,024			\$1,715,412
II. SUPERVISION					
PLANT OPERATING SUPERVISOR	\$34,500/YR	2,080	\$ 34,500	1.42	\$ 48,990
YARD OPERATIONS SUPERVISOR	\$24,000/YR	4,160	\$ 48,000	1.42	68,160
SHIFT ENGINEER	\$27,600/YR	<u>23,712</u>	\$314,640	1.42	<u>446,789</u>
SUBTOTAL SUPERVISION		29,952			\$563,939
TOTAL STAFF REQUIREMENTS					
		170,976			\$2,279,351

* WHEN COMPENSATION RATE IS GIVEN IN \$/OPER/YEAR

BASE COST/YEAR = [(HRS/YEAR) ÷ (2080 HRS/OPER)] • (\$/OPER/YEAR)

THE BDM CORPORATION

TEXACO/MBG PROCESS OPERATING REQUIREMENTS FOR EXPECTED OPERATIONS (INDIVIDUAL OPERATING REQUIREMENTS FOR MODULES III AND IV)

	BASIS	UNITS
Raw Materials		
Coal	TPY @ 100% Operation	1,825,000 TPY
Raw Water (@ 2533 gpm design)	Gallons/Year @ 100% Operation	1.33 Gallons/Year x 10 ⁹
Catalyst and Chemical Makeup		
Makeup	@ 100% Operation	\$ 255,000/Year
Initial Charge of Catalysts and Chemicals		\$ 607,000
Utility Requirements		
Import Power (@ 49,500 KW)	Kwh/Yr @ 100% Operation	433,620,000 Kw-Hr/Yr
Operating Requirements		
Labor		
Supervisors	mh/Yr	29,952 mh/Yr
Operators	mh/Yr	141,024 mh/Yr
Supplies	Factored as 15% of operating labor costs	
Maintenance Requirements		
Labor	Factored as 1.6% of average modular total system cost	
Supplies	Factored as 2.4% of average modular total system cost	
General Plant Staff	Factored as 30% of operating labor and maintenance labor & supervision	
Administration and Plant Overhead	Factored as 5% of operations & maintenance less feedstock and chemicals	
Total Net MBG Yield =	@ 100% Operation	28,581,000 MMBTU/YEAR
		98.335 x 10 ⁹ SCF/YEAR

THE BDM CORPORATION

TEXACO/MBG PROCESS ANNUAL MODULE OPERATING COSTS FOR EXPECTED OPERATIONS (INDIVIDUAL MODULE COSTS FOR MODULES III AND IV) MILLIONS OF JANUARY 1980 DOLLARS

ITEM DESCRIPTION	UNITS	NET REQUIREMENTS (AT 100% OPERATION)	ANNUAL REQUIREMENTS (AT 90% OPERATION)	COST PER UNIT	ANNUAL COST (x 10 ⁶)
FEEDSTOCK: (KENTUCKY #9 SEAM, DEEP MINE)*	MMBTU	1.098 x 10 ⁵ MMBTU/DAY	3.607 x 10 ⁷ MMBTU/YEAR	\$1.25	\$45.087
CATALYST & CHEMICAL MAKE-UP					\$ 0.230
SUBTOTAL FEEDSTOCK & CATALYST & CHEMICALS					<u>45.317</u>
ELECTRIC POWER	KWH	49,500 KW	390,258,000 KWH/YEAR	\$0.027 KWH	\$10.537
WATER	10 ³ GALLONS	2,533 gpm	1.198 x 10 ⁹ gal/year	\$0.80/ KGAL	\$ 0.959
OPERATING LABOR		141,024 hrs/year	141,024 hrs/year	\$12.16	\$ 1.715
OPERATING SUPPLIES	(15% of Operating Labor)				\$.257
MAINTENANCE LABOR	(1.6% OF 1/4 of Total Facility Investment)				\$ 6.558
MAINTENANCE SUPPLIES	(2.4% OF 1/4 of Total Facility Investment)				\$ 9.838
SUPERVISION			29,952 hrs/year	\$18.83	\$.564
GENERAL PLANT STAFF	(30% of Operating Labor, Maintenance Labor and Supervision)				\$ 2.651
ADMINISTRATION AND GENERAL OVERHEAD	5% Factor of Subtotal of O&M Expenses (Less Feedstock and Catalysts)				\$ 1.654
PROPERTY TAXES AND INSURANCE					-0-
SUBTOTAL O&M COSTS LESS FEED- STOCK & CATALYST & CHEMICALS					<u>\$ 34.733</u>
GROSS ANNUAL OPERATING & MAINTENANCE COSTS					\$ 80.050
BYPRODUCTS CREDITS					-0-
NET ANNUAL OPERATING & MAINTENANCE COSTS					<u>\$ 80.050</u>

* MEAN BTU VALUE OF FEEDSTOCK = 10,980 BTU/LB.
21.96 MMBTU/TON

THE BDM CORPORATION

g. Koppers-Totzek/Texaco/SNG Present Value of Capital and Operations and Maintenance Costs and Product Prices

THE BDM CORPORATION

PRESENT VALUE OF CAPITAL AND OPERATING & MAINTENANCE COSTS

KOPPER-TOTZEL/TENACO/SNG PROCESS
(AT 90 PERCENT OPERATING CAPACITY)
MILLIONS OF DOLLARS

ITEM DESCRIPTION	GENERAL FACILITY	K-T/SNG MODULE 1	COMBINED 1+1/4 GF	TENACO/SNG MODULE 2	COMBINED 1+2+1/2 GF	TENACO/SNG MODULE 3	COMBINED 1+2+3+3/4 GF	TENACO/SNG MODULE 4	TOTAL FACILITY
OPERATING AND MAINTENANCE EXPENSES									
FEEDSTOCK		496.95		477.68		468.11		458.81	
CATALYST & CHEMICALS		18.24		15.00		2.38		2.34	
SUBTOTAL		515.19		492.68		470.49		461.15	
ELECTRIC POWER		263.04		75.27		97.48		95.43	
WATER		3.34		3.09		3.24		3.07	
OPERATING LABOR		25.09		23.13		16.56		16.23	
OPERATING SUPPLIES		3.76		3.47		2.48		2.43	
MAINTENANCE LABOR		69.12		66.37		65.01		63.70	
MAINTENANCE SUPPLIES		103.68		99.55		97.51		95.55	
SUPERVISION		6.59		6.33		5.45		5.34	
GENERAL PLANT		29.70		28.23		25.60		25.09	
ADMIN. & GENERAL		25.73		15.49		15.97		15.65	
PROPERTY TAXES & INS.		0.00		0.00		0.00		0.00	
SUBTOTAL		530.05		320.93		329.30		322.49	
SUBTOTAL O&M COSTS		1045.24		813.61		799.79		783.64	3442.28
CAPITAL COSTS									
DEPRECIABLE INVESTMENT COSTS	143.88	518.42		458.04		384.61		421.79	
NON-DEPRECIABLE INVESTMENT COSTS	1.31	18.89		15.63		11.36		11.57	
SUBTOTAL CAPITAL COSTS	145.19	537.31	573.61	473.67	1083.58	395.97	1515.85	433.36	1985.50
PRESENT VALUE OF TOTAL CAPITAL AND O&M COSTS	145.19	1582.55	1618.85	1287.28	2942.43	1195.76	4174.49	1217.00	5427.76
SNG ANNUAL PRODUCT (MMBTU)		17518248	17518248	20100258	37618506	-0-	37618506	-0-	37618506
MBG ANNUAL PRODUCT (MMBTU)		-0-	-0-	-0-	-0-	25722900	25722900	25722900	51445800
PRODUCT PRICE (\$/MMBTU)									
(JANUARY 1980 DOLLARS)		\$ 9.31	\$ 9.31	\$ 6.94	07			\$ 5.27	\$ 6.49
UNIT-TERM ANNUAL TOTAL INVESTMENT									
LOST OF SERVICE (\$/MMBTU)									
(CURRENT DOLLARS)		\$23.08	\$23.08	\$18.42	\$20.72			\$ 14.70	\$17.45

(MODULES, 384)

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4. Lurgi-Methane and Lurgi-Methane-and-Methanol

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THE BDM CORPORATION

	<u>LURGI/METHANE</u>	<u>LURGI/METHANE & METHANOL</u>
TOTAL CAPITAL INVESTMENT	3473	3560
OPERATIONS AND MAINTENANCE PLUS FEED	430	399
BY-PRODUCT REVENUE (COAL FINES)	47	47
90% YIELD (10 ¹² BTU/year)	94.37	109.30
SNG METHANOL	94.37 -0-	58.42 50.88
INTEGRATED PRICE (\$1980/MMBTU)	\$ 7.69	\$ 6.81

NOTE: All costs in millions of dollars.

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Summary of Facility Costs for Lurgi Alternate Products

THE BDM CORPORATION

TOTAL CAPITAL REQUIREMENTS -- ADD-ON METHANATION FACILITY (FOUR MODULES)

UNIT OPERATION	CAPITAL INVESTMENT MILLION DOLLARS
SHIFT CONVERSION	20.42
ACID GAS REMOVAL	160.26
METHANATION	98.44
GAS DRYING	1.60
COOLING WATER	53.12
STEAM SUPERHEAT	18.79
RAW WATER TREATING	14.55
SOLIDS TREATING	23.80
BUILDINGS AND ELECTRICAL DISTRIBUTION	<u>12.12</u>
SYSTEM CAPITAL INVESTMENT (ADD-ON METHANATION FACILITY)	403.10
PROJECT CONTINGENCY	60.47
OWNERS ENGINEERING & G AND A	9.64
CONTRACTOR'S FEE	<u>18.54</u>
	491.75
SYSTEM CAPITAL INVESTMENT (LURGI BASE FACILITY)	<u>1,879.00</u>
TOTAL FACILITY INVESTMENT	2,370.75
ROYALTIES	11.85
AFUDC	506.31
START-UP AND TESTING	<u>483.09*</u>
TOTAL DEPRECIABLE INVESTMENT	3,372.00
NON-DEPRECIABLE INVESTMENT	<u>101.16</u>
TOTAL CAPITAL REQUIREMENTS	<u><u>3,473.16</u></u>

*Includes coal used during start-up and testing.

THE BDM CORPORATION

ANNUAL OPERATING AND MAINTENANCE COSTS --
ADD-ON METHANATION FACILITY (FOUR MODULES)

MILLION DOLLARS

OPERATING LABOR	1.88
OPERATING SUPPLIES	0.28
MAINTENANCE LABOR	1.97
MAINTENANCE SUPPLIES	2.95
SUPERVISION	0.14
GENERAL PLANT STAFF	1.20
CATALYST AND CHEMICALS	6.76
ELECTRIC POWER	12.30
ADMINISTRATION AND GENERAL OVERHEAD	<u>1.04</u>
ANNUAL OPERATING COSTS (ADD-ON METHANE FACILITY)	28.52
 ANNUAL OPERATING COST (LURGI BASE PLANT)	 <u>366.38</u>
TOTAL ANNUAL OPERATING COSTS	<u>429.99</u>

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TOTAL CAPITAL REQUIREMENTS -- ADD-ON METHANE/METHANOL FACILITY (FOUR MODULES)

UNIT OPERATION	CAPITAL INVESTMENT MILLION DOLLARS
METHANOL SYNTHESIS	100.76
ACID GAS REMOVAL	153.12
METHANATION	49.16
COMPRESSION	23.36
GAS DRYING	1.16
CO ₂ REMOVAL	40.20
COOLING WATER	70.11
STEAM SUPERHEAT	14.48
RAW WATER TREATING	27.96
BY-PRODUCT STORAGE	15.24
BUILDINGS AND ELECTRICAL DISTRIBUTION	<u>15.36</u>
SYSTEM CAPITAL INVESTMENT (ADD-ON METHANATION FACILITY)	510.91
PROJECT CONTINGENCY	76.64
OWNERS ENGINEERING & G AND A	12.22
CONTRACTOR'S FEE	<u>23.50</u>
	623.27
SYSTEM CAPITAL INVESTMENT (LURGI BASE FACILITY)	<u>1,879.00</u>
TOTAL FACILITY INVESTMENT	2,502.27
ROYALTIES	12.51
AFUDC	534.38
START-UP AND TESTING	<u>408.27*</u>
TOTAL DEPRECIABLE INVESTMENT	3,457.43
NON-DEPRECIABLE INVESTMENT	<u>102.16</u>
	<u><u>3,559.59</u></u>

*Includes coal used during start-up and testing.

THE BDM CORPORATION

ANNUAL OPERATING AND MAINTENANCE COSTS -- ADD-ON METHANE/METHANOL FACILITY (FOUR MODULES)

MILLION DOLLARS

OPERATING	2.43
OPERATING SUPPLIES	0.36
MAINTENANCE LABOR	2.49
MAINTENANCE SUPPLIES	3.74
SUPERVISION	0.14
GENERAL PLANT STAFF	1.52
CATALYST AND CHEMICALS	5.32
ELECTRIC POWER	15.13
ADMINISTRATION AND GENERAL OVERHEAD	<u>1.29</u>
ANNUAL OPERATING COSTS (ADD-ON METHANE FACILITY)	32.42
ANNUAL OPERATING COST (LURGI BASE PLANT)	<u>366.38</u>
TOTAL ANNUAL OPERATING COSTS	<u>398.80</u>

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